BELL LABORATORIES RECORD

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A monthly magazine for members of Bell Telephone Laboratories, for their associates in the Bell System and for others interested in the progress of the communication art. During the war some 90 per cent of the Laboratories' activities were devoted to producing communication and electronic apparatus for the Armed Forces. In peace, the Laboratories' work is the development of apparatus and systems for manufacture by the Western Electric Company and use by the Bell System.

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The Cover—Firing 4.5-inch rockets from a multiple rocket launcher mounted on an M4 tank with the Seventh Army in France. Rockets are being fired singly; the multiple effect shown is due to time exposure.—*Signal Corps Photo.*

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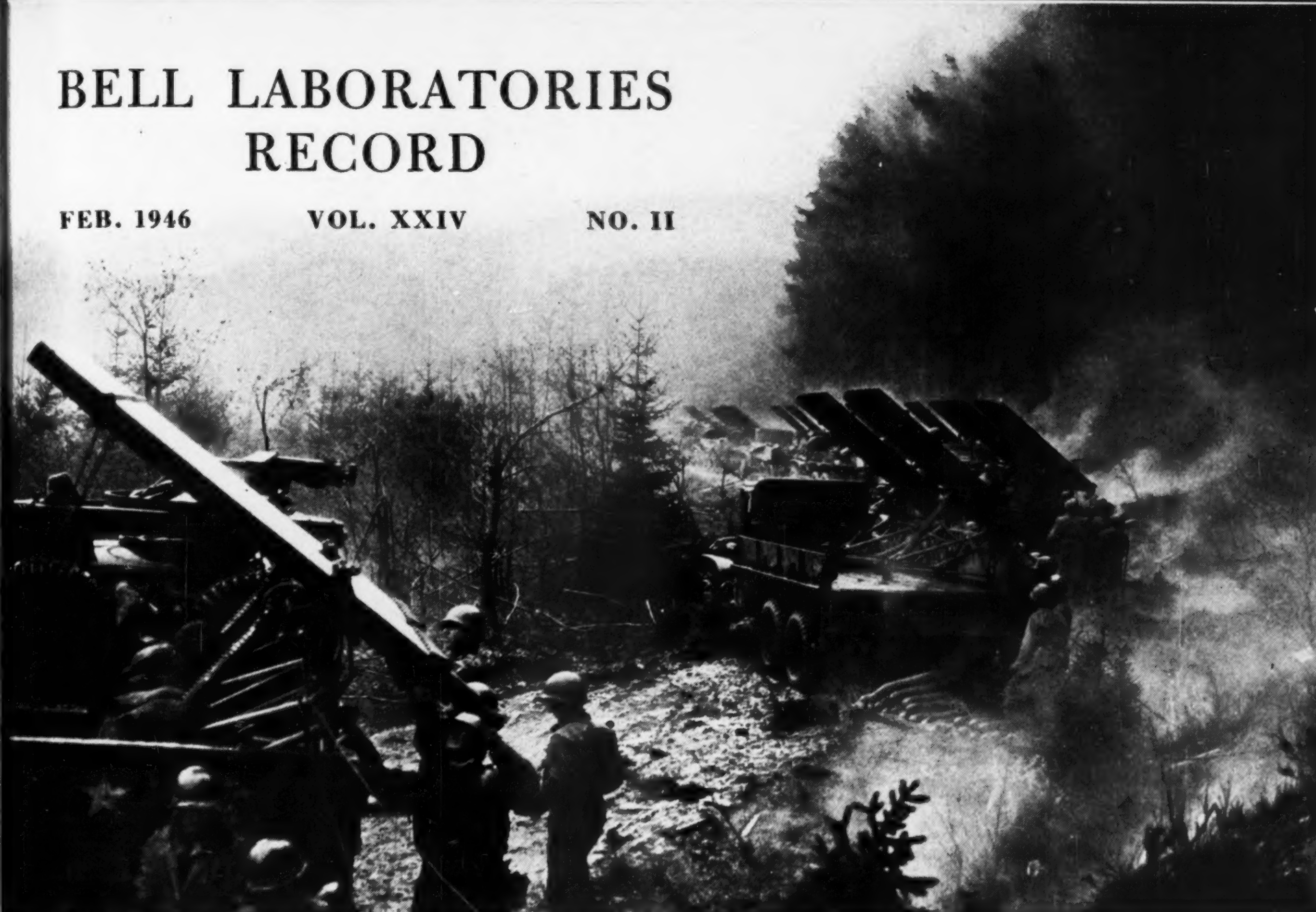


Multiple Tube Rocket Launchers

By H. O. SIEGMUND

Switching Apparatus Development Engineer

DURING World War I, Dr. C. N. Hickman had worked intimately with Professor R. H. Goddard, of Clark University, who was a pioneer in scientific rocket development. Sensing the importance of rocket-propelled projectiles in modern warfare, Hickman prepared memoranda in June, 1940, which clearly stated the possibilities of jet-propelled ordnance devices. Applications that were suggested included armor-piercing bombs, rockets for the projection of chemicals, rockets for tank and aircraft mountings, for ships and submarines, and for use by the infantry. These ideas were passed along to Dr. F. B. Jewett, who was a member of the National Defense Research Committee. As a result, the services of Dr. Hickman were given to the Government, where he has served as chairman of one of the NDRC sections on rocket development for more than five years.

Through Dr. Hickman, the small group of scientific men who were gathered initially to set up Government rocket ballistics laboratories were familiar with the work of Bell Laboratories, and called on them for assistance in designing dependable control systems. Trouble from faulty contacts had been experienced in some of the experimental fire-control systems, and since nothing is more disconcerting in service than to push a firing button and have the device fail to go off, the Laboratories' experience in contact and switching design was urgently needed.

A good example of the application of communication techniques to rocket problems is provided by the fire-control mechanisms developed for setting off rockets in multiple-tube launchers. The Army was working on an arrangement to launch 7.2-in. rockets from a large truck in which the launching gear was housed in the body of

Fig. 1—A twenty-tube launcher on demolition tanks for throwing 7.2-inch rockets

the vehicle. It was desired that electrical arrangements for setting off the rockets in succession should be controlled by a selecting mechanism removed about 50 feet from the truck and connected to it by a long cable. The problem was to obtain a timed selecting arrangement that would discharge the rockets in succession as close together as possible without having them collide in the air or having the blast from one rocket affect the trajectory of the succeeding one. To meet this problem, the Laboratories designed a fire-control arrangement around their 200-type telephone selector with an associated relay timing circuit that enabled the rockets to be discharged in succession as required. It took about a week's time to have a model in the hands of the Army, and the Western Electric Company was commissioned soon thereafter to build nearly a hundred of these devices for further field experiments.

This first ripple fire-control mechanism, built around the 200-type selector, attracted attention to similar problems on rocket launchers for tanks and other mobile mounts. On a rush basis, the Laboratories designed fire-control devices for tanks that carried 60-tube launchers, for demolition tanks that threw twenty 7.2-in. missiles for breaking up heavy defenses, Figure 1, and for 8-tube launchers on truck and trailer mounts. The photograph at the head of this article shows the latter in action in the Hurtgen Forest, Germany. All of these fire controls, built around telephone switches and relays, were found to provide substantial improvement over earlier designs with respect to the reliability of firing, and the Western Electric Company was placed under contract to build several hundred of each kind of launcher controls for equipment to be sent overseas. Much of this was used effectively in the European theater of operations, as shown in the photographs taken there.

The 60-tube rocket launcher, shown on the cover of this issue, was mounted immediately above the turret of the General Sherman M4 tank. When tanks are landed on enemy beaches, maximum fire power is needed to clear out gun emplacements and

troop concentrations immediately in the path of the assault. Once this has been accomplished, the normal armament of the tank is sufficient, but for the brief ordeal of breaking through a line of strong defenses, the greater the fire power that can be brought into use, the less will be the cost in lives. Sixty-tube rocket launchers are mounted on a simple steel frame fastened to the turret of the 75-mm gun and are swung with the turret. A rigid steel strut connects the frame to the gun barrel in such a way that the elevation of the rocket launcher is related to that of the gun. The rockets are thus aimed by the same control that aims the gun. Once the rockets have all been fired, the rocket launcher becomes excess baggage and might interfere with further maneuvering. It is therefore arranged so that it may be dropped off of the tank merely by disconnecting the electrical control leads and tripping a hydraulically operated latch, which is done from inside the turret. The launcher may be salvaged for further use.

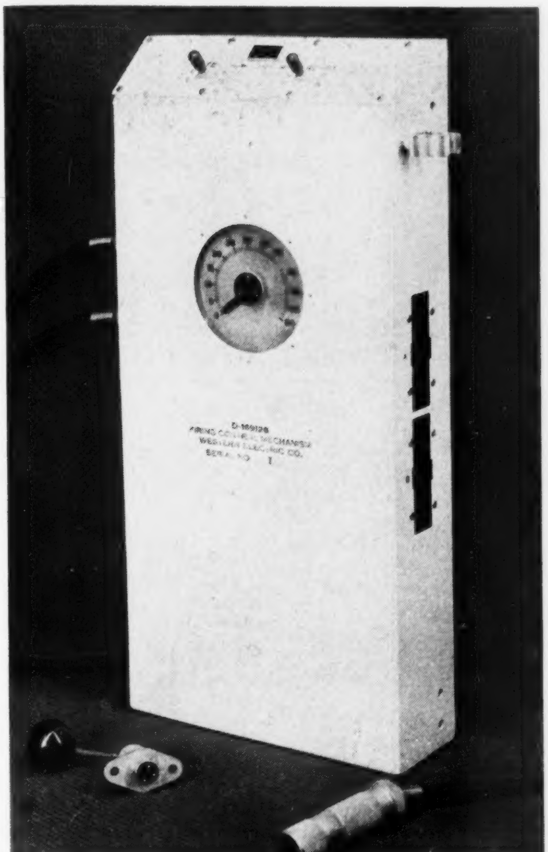


Fig. 2—Front view of fire-control unit for the T-34 sixty-tube launcher so successfully used on M4 tanks

The fire-control apparatus has been so designed as to permit the rockets to be launched singly or in rapid succession. Most of the fire-control apparatus is installed in a small unit, Figures 2 and 3, which is mounted inside the turret. For the most part, the circuit includes standard telephone equipment such as selectors, relays, jacks and keys. An indicator on the front of the control cabinet shows at all times the number of rockets remaining. Control of firing is through a button on the end of a flexible cable which permits operation from any part of the tank. Firing leads from the control to the launchers are carried in cables through one of the periscope openings of the tank.

With such a large amount of high explosive immediately above the turret, every precaution had to be taken to avoid pre-

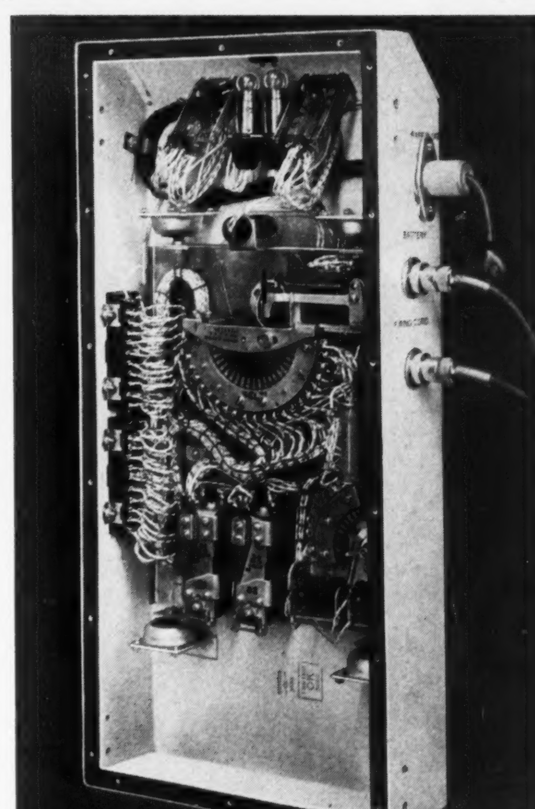


Fig. 3—Rear view of fire-control unit of T-34 launcher with cover removed to show the 200-type selector and the other associate telephone apparatus

mature firing. The entire circuit is made inoperative at all times except when in use by a removable safety plug which is carried by the tank commander. To prevent the blast of one rocket from interfering with the trajectory of an adjacent one, the firing sequence is arranged to select alternate launcher tubes in succession. Adjacent rockets are thus never fired in immediate succession.

To meet the Army's needs for the procurement of fire-control mechanisms in the shortest possible time, a production program was set up. Under this program, design was started on October 1, 1943, orders for initial production were received by the Western Electric Company about the first of January, 1944, and the manufactured product was crated for foreign shipment by the end of February, 1944. Were it not for the fact that standard telephone apparatus, such as relays, selectors, keys, jacks and signal lamps were already developed and in production, and had the required dependability, such rapid performance would have been impossible.

THE AUTHOR: H. O. SIEGMUND, Switching Apparatus Development Engineer, received a B.S. degree from the University of Illinois in 1917 and an E.E. degree in 1926. After service in the Aviation Section of the Signal Corps during World War I, he taught physics and electrical engineering at Drexel Institute; he then came to the Engineering Department of the Western Electric Company in 1919. His work has been concerned principally with the development of telephone apparatus, first in connection with aluminum electrolytic condensers and filters to reduce background noise and improve transmission in telephone circuits, and then in connection with panel, step-by-step and crossbar switching apparatus, ringers and dials. During World War II he was project engineer on proximity fuse developments for underwater ordnance and for rocket developments, and was concerned with work on sonar, radar, and fire-control systems.

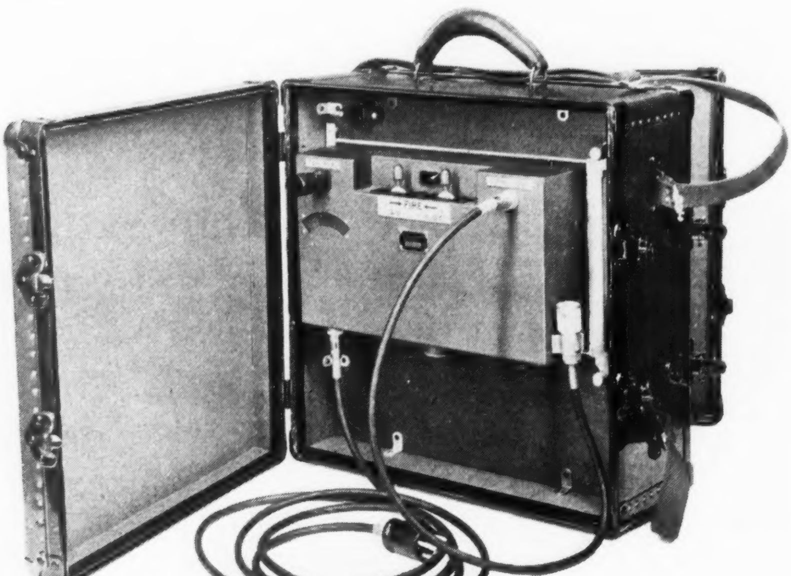


Fig. 4—Fire-control unit for the truck-mounted eight-tube T-27 rocket launcher

Fatigue Cracking of Coated Lead Alloys

By LAWRENCE FERGUSON
Chemical Laboratories

THE lead alloy sheaths of telephone cables are subjected in service to a wide range of climatic conditions. Among these are day to night and seasonal temperature changes which cause aerial cables and their steel supporting strands to expand and contract at different rates. Some of the resulting motion is concentrated in comparatively narrow regions, usually near the poles, and may eventually cause the sheath to crack. The extreme bending which can be produced at the poles by temperature changes on an experimental pole line specifically installed for fatigue studies at the Chester, N. J., field laboratory is shown in the headpiece. The movement in these bows often produces buckles in the sheath, Figure 1, and fatigue cracks are frequently found in these buckles.

Cable sheaths are also subjected to rain and chemical effects of the atmosphere. If buried without protective covering or in conduit, their chemical environment may include water in which are dissolved salts, acids, or alkalis that attack the sheath. Stray electric currents may augment these corrosive effects.

Published reports having indicated that corrosion may affect adversely the fatigue resistance of various metals and alloys, it became desirable, some years ago, to obtain information on the corrosion-fatigue characteristics of cable sheath alloys. In the first experiment, specimens of lead to which one per cent of antimony had been added were flexed repeatedly in water taken from a manhole. A reduction in life was expected, but, instead, the fatigue test continued without failure for many times the normal number of cycles. This led to experiments to learn the effect on the fatigue properties of various lead alloys of coating their surfaces with different materials.

Tests were carried out on specimens about eight inches long, three-quarters of an inch wide, and one-eighth of an inch thick which were held between a fixed and a movable clamp, as shown in Figure 2. The movable clamp slid on a steel rail and was given a reciprocal motion by an eccentric. This motion caused considerable bending at the middle of the curved section of the specimen and minor bending near the jaws of the machine. Electrical and mechanical devices were provided to count the number of cycles to failure, for determining the speed of the machine, and for stopping it when the last specimen had failed. Rates of motion varied from two to 88,000 cycles per hour and the deflections from 0.015 to 0.100 of an inch.

Results reported here are limited chiefly to the effect of a coating of polybutene, a viscous tacky polymerized isobutylene, on four cable sheath alloys. The compositions of the alloys were chemical lead, which contains 0.06 per cent copper and 0.007 per cent silver as normal constituents; chemical lead plus 0.25 per cent and also 1 per cent antimony; and chemical lead plus 0.035 per cent calcium.

In all of these alloys, except the 100 per cent chemical lead, changes in structure and in mechanical properties take place at

Fig. 1—Bowing in cables sometimes makes the sheath buckle and causes fatigue cracks

room temperature with age. The relatively short duration of the tests, however, kept these changes small except in the lead +1 per cent antimony alloy. Appreciable structural changes were observed in this alloy during tests which lasted one month or more, but they were similar to those which occur in cable sheath of this composition during service in the field.

Figures 3A to D show the relationship between rate of working and fatigue life for the four alloys, when uncoated and when coated with polybutene. These data indicate that fatigue life varies with the rate of motion, probably because the lead alloys have more time to flow plastically at low than at high speeds of operation and so receive more plastic deformation in each cycle; and that a polybutene coating is protective at high but harmful at low speeds.

Figures 4A to D show how fatigue life is affected by the amplitude of motion for both coated and uncoated specimens. When the deflection is increased, the amount of plastic deformation per cycle increases and the specimens fail after fewer cycles. The effect of the polybutene coating was not determined for small deflections at low speeds because too much time would have been required, but the coating is more protective at small deflections than at high ones, as far as the curves in Figure 4 extend. Figures 3 and 4 indicate that the polybutene coating is protective when the plastic deformation per cycle is small, but becomes harmful when it is great.

Figure 5 summarizes the data for the four alloys at the highest testing speed. This and Figures 3 and 4 show that the relative fatigue quality of the four alloys cannot be stated without reference to the amplitude and rate of motion and to the presence or absence of a polybutene coating. Probably other test variables, especially temperature, also are important in comparing alloys.

Materials other than polybutene were tried as coatings on fatigue specimens, but none that remained fluid adhered so well. These coatings were generally tested with small deflections at high speed, the conditions which usually give protection. The protective effect of paints which were fluid when applied but dried later correlated closely in hours of working before failure with the time required for drying. Some materials, such as raw linseed oil, were too fluid and left too thin a coating to be effective. Paraffin was not fluid enough to adhere well and had almost no effect. Machine oil and water were highly protective when tests were run with the specimens immersed in them.

The mechanism by which polybutene and other coating materials affect fatigue life is not well understood. One theory suggests that a fluid, by wetting or adhering to the surface of a specimen, forms a con-

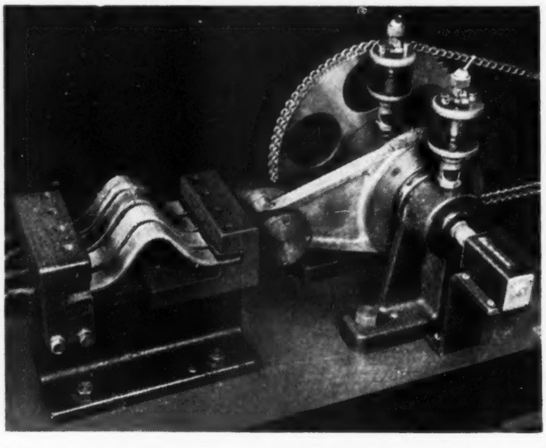


Fig. 2—Specimens of cable sheath are tested for the effect of repeated bending by subjecting them to a reciprocal motion which caused deflections from neutral of 0.15 *to* 0.10 *of an inch at different frequencies*

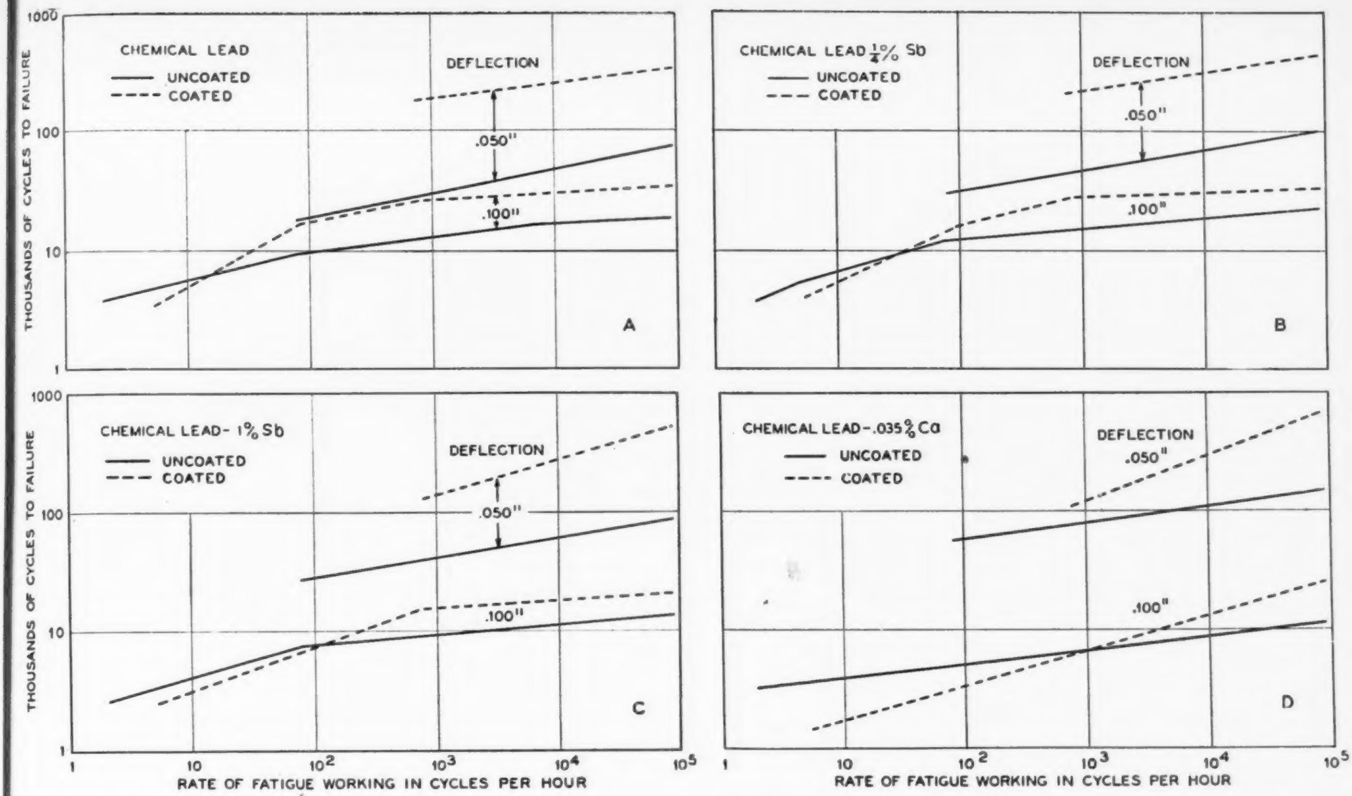


Fig. 3—Fatigue life increases with the rate of motion. A polybutene coating is helpful at high but harmful at low speeds

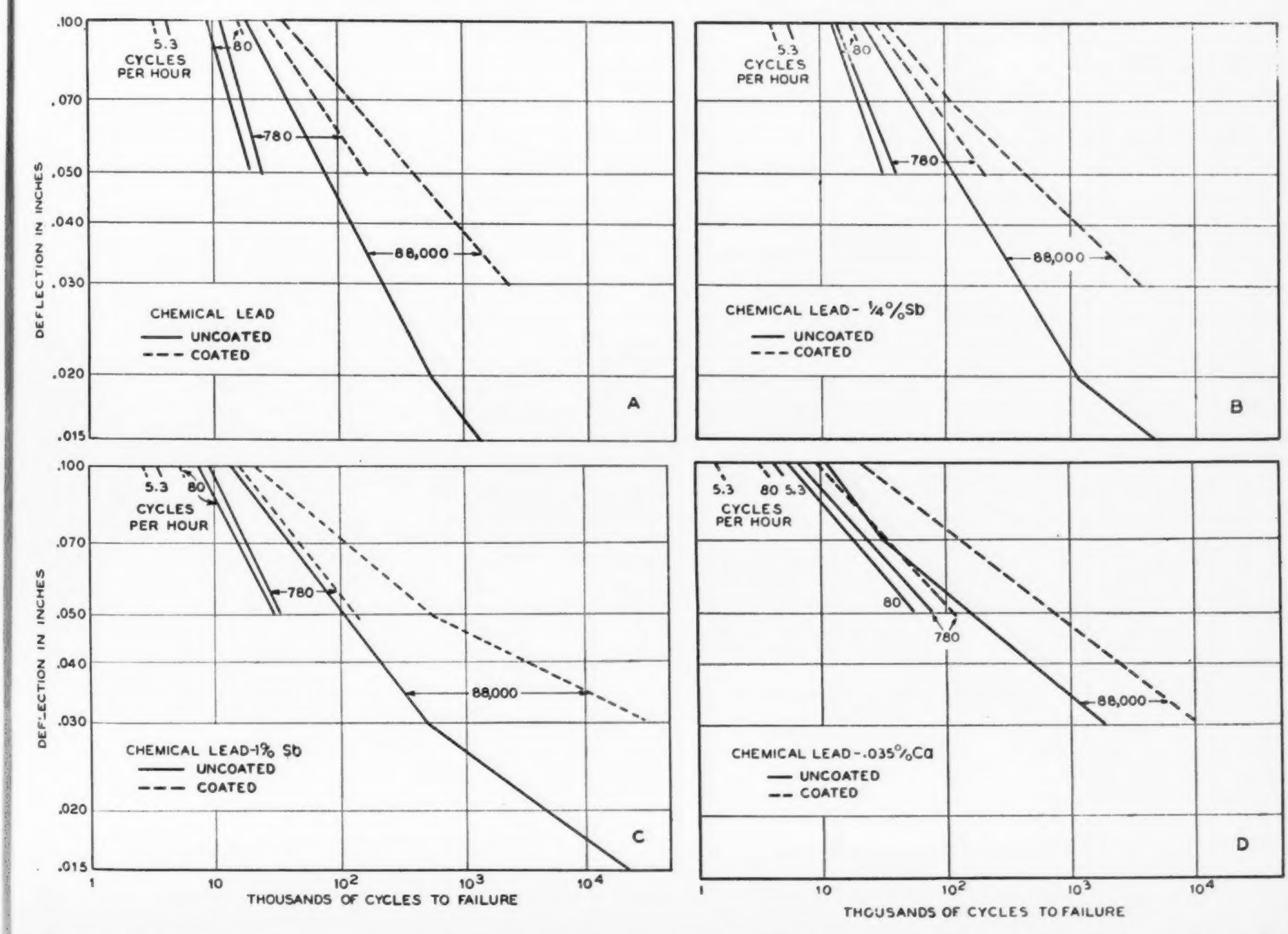


Fig. 4—Failure occurs sooner with large deflections. A polybutene coating is protective when the deformation is small

tinuous layer which may be considered as part of the specimen. From this viewpoint the protective effects which occur at high speeds and small deflections may be due to the fluidity of the coating providing a surface without scratches or other defects which would act as stress raisers. Such a surface favors abnormally long fatigue life. The amorphous character of the coating, which is bonded to the metal by forces of adhesion, may also offer strong resistance to the formation of cracks. Eventually, when cracks penetrate into the metal, the coating may tend to hold the edges and walls of the cracks together and thus reduce the concentration of motion at the crack. This seems especially likely at small deflections, where the widths of the cracks are small and the adhesive forces of the coating may be more effective.

As the deflection becomes large, or the speed slow, the coating material may be drawn into and forced out of cracks with each cycle of fatigue motion. While being forced out by the fatigue motion, material in the crack may act as a wedge tending to increase the width of the crack and reduce fatigue life.

THE AUTHOR: LAWRENCE FERGUSON joined the Engineering Department of the Western Electric Company in 1923. After completing a three-year series of student assistant courses and various out-of-hour courses, he went to New York University and received a B.S. degree there in 1931. Mr. Ferguson's work in the Research Department of the Laboratories has included studies of the thermionic activity of materials for vacuum-tube filaments, the diffusion of water through rubber, resistance welding, and permanent magnet alloys as well as experiments with lead cable sheath alloys, some of which are reported in this article.

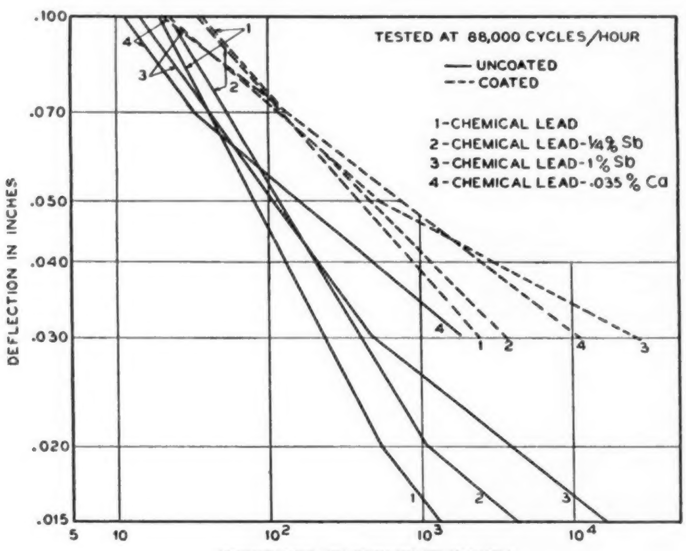
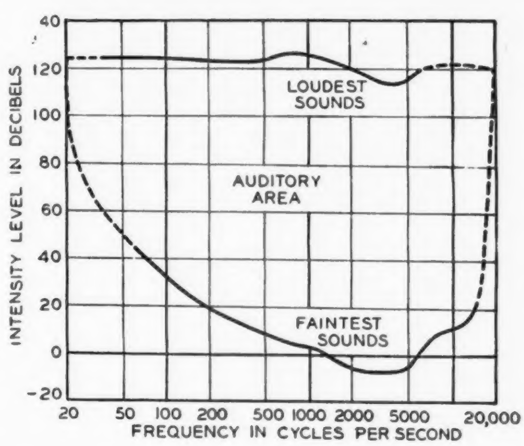


Fig. 5—Relative fatigue quality of cable sheath alloys cannot be stated without reference to amplitude of motion and other test variables.

Historic Firsts: The Audiometer

UNTIL the 1920's, available methods of measuring hearing were satisfactory only because no better methods were known. They failed to give either a precise quantitative measure of hearing or a satisfactory qualitative measure. Moreover, there was no complete and dependable data as to the limits of normal hearing in either volume or frequency, and thus there were no standards by which the measurements that were made could be universally compared. The ticking of a watch at various distances was perhaps the most commonly used criterion, but those attempting more extensive measurements used a set of some dozen or more tuning forks supplemented by a Galton whistle or a monochord for the higher frequencies. The procedure was to strike a fork and hold it a fixed distance from the patient's ear. As the vibrations died down, the sound would decrease in volume, and by timing the interval from the initial excitation of the fork to the time the patient ceased to hear, a measure of hearing for that frequency would be obtained. Minor differences in procedure and equipment of the various otologists naturally prevented any very accurate inter-comparison of their results.



Normal hearing is bounded by the thresholds of hearing and feeling

Both the determination of normal hearing and the development of adequate measuring apparatus are large undertakings, and for the most part are beyond the scope of individual physicians, who were most in need of the information they would give. Hearing, however, is also important to the successful operation of the Bell System, and with the continuous improvements that had been made in telephone circuits and instruments, a point had been reached where more exact knowledge of the extent and quality of normal hearing and of the prevalent forms of impairment were required to permit further development to follow the most effective course. To gather the necessary information, an investigation was undertaken, largely under the direction of Dr. Harvey Fletcher and R. L. Wegel, to determine the hearing ability at various frequencies of a large number of people of both sexes.

Techniques for controlling and measuring losses over a wide range of frequencies that are now a matter of daily routine were at that time only beginning to be developed. The provision of measuring techniques and apparatus for this new undertaking was thus pioneering in its own right. Oscillators capable of providing tones of frequencies over the entire audible range had to be provided, and attenuators had to be built to reduce the output in steps that would be recognized as equal by the ear. This meant that the attenuation had to be increased in logarithmic steps. Heretofore, laboratory practice had secured decreases in voltage by some device such as a slide wire, but in attempting to use a slide wire for hearing measurements, it was found that all the important steps were crowded together at the low-voltage end of the wire. Hearing losses are not of much importance unless they exceed 20 db—a measure not then thought of—and all steps above 20 db would be within one per cent of the end of the wire. Since

no suitable attenuators were available, they had to be made. Then high-quality telephone receivers had to be provided that were capable of faithful reproduction over a wide range of audible frequencies.

In general, the procedure was to apply a tone of some particular frequency, and to decrease the volume step by step until it could just be heard. By repeating such measurements for a large number of frequencies and for many individuals, it was possible to obtain a curve representing the lowest audible volume at the different frequencies for the average person of good hearing. Since it had been known for a long time that hearing ability decreased with age, the tests were made with people from eighteen to twenty-three years of age, which otologists agreed covered the period when our hearing is most acute. The curve obtained in this manner was known as the threshold of hearing.

Properly speaking, there is no upper limit to the volume of an audible sound, but tests soon showed that there was a volume at which the sound was felt rather than heard —a volume at which the tactile response overrode the audible response. At volumes much greater than this, the sound becomes painful, and thus for all practical purposes there is an upper as well as a lower limit to the volume of usable sound. This upper limit was also determined, and was called the threshold of feeling. Plotting these two thresholds and extrapolating beyond the test data at the higher and lower frequencies, as indicated by the dashed lines in the illustration, revealed a definite auditory sensation area.

This information was reported in the *Proceedings of the National Academy of Sciences* for January 15, 1922, and in the *Physical Review* for June, 1922. A diagram of the auditory sensation area was published in the *Proceedings of the National Academy of Sciences* in July, 1922. Dr. E. P. Fowler of New York City coöperated with Mr. Wegel in much of this early work, and with him presented a joint paper on *Audiometric Methods and Their Applications* before the American Laryngological, Rhinological, and Otological Society at a meeting held in May, 1922.

These studies made available for the first time a map of the realm of hearing. By measuring a person's threshold of hearing and superimposing it on the auditory sensation area, a quantitative indication of the degree of hearing impairment is immediately evident. The great potential value of such a procedure in diagnosing and treating hearing impairments is obvious. To make the method generally available, however, apparatus that could be conveniently used by physicians was needed. The first effort in this direction by Bell Telephone Laboratories was the development of the 1A Audiometer. It could make measurements over a frequency range from 32 to 16,000 cycles, essentially the entire width of the auditory area. One of these was turned over to Dr. Fowler, who has made extensive use of it. Although very satisfactory as far as giving accurate measurements is concerned, it was too large and expensive for general use. To provide apparatus with a wider field of usefulness, the much smaller and more compact 2A Audiometer was developed shortly afterward. Its frequency range was somewhat narrower—extending from 64 to 8,000 cycles—but was wide enough for all ordinary purposes.

As with any radically new apparatus and procedure, general acceptance was not at once accorded. As the value of the Laboratories' contribution in this field became recognized, however, and as it was further recognized that their objective was not to sell a new piece of apparatus, the initial hesitancy in adopting the new methods began to evaporate. Mr. Wegel was given honorary membership in the American Otological Society, and a similar recognition was extended Dr. Fletcher somewhat later. The further coöperation of both Dr. Fletcher and J. B. Kelly with the medical profession in building special test equipment and establishing standards rapidly allayed any lingering skepticism, and today audiometric measurements are the foundation not only of diagnosis, but of the prescription of remedial means.

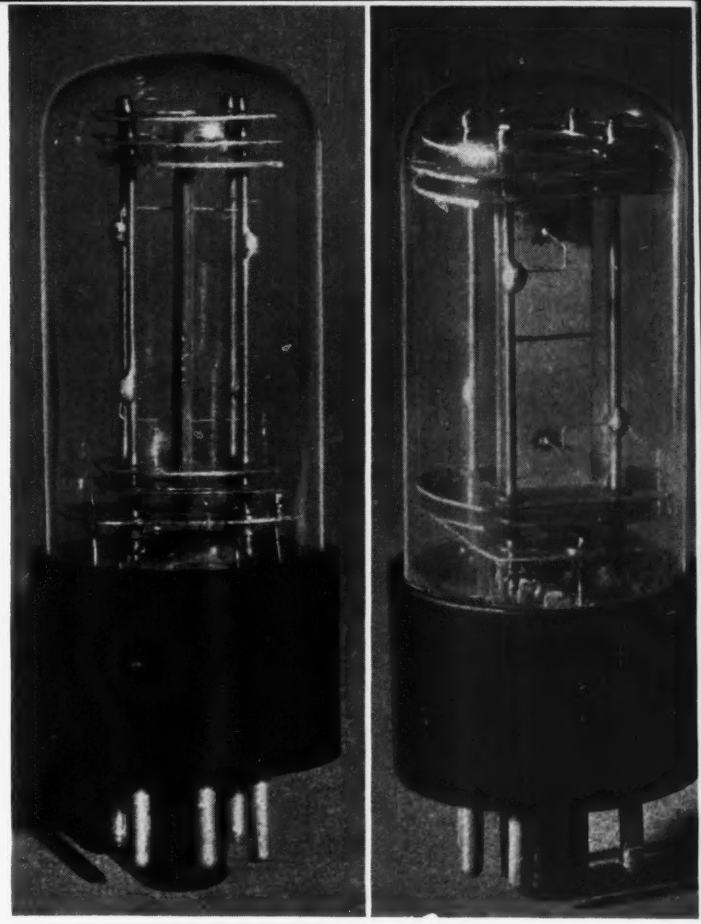
Duplex Crystals

By C. E. LANE

Transmission Network Engineering

QUARTZ crystals have proven of inestimable value in communication work because of their stable physical, electrical, and piezo-electric properties. Their natural rates of vibration in the usual modes are high, however, and where low frequencies are desired, frequency translation has been required at one or more points of the circuit. An ordinary quartz plate vibrating longitudinally would have to be over 8 feet long to give a frequency of 1 kc, which, of course, would be entirely impractical. This disadvantage has recently been overcome by the development of the duplex crystal, consisting of two plates bonded together. For a frequency of 1 kc, such a crystal would require a length of less than 3 inches. Duplex plates find their greatest use in the range of frequency from a little below 1 kc up to 10 kc or somewhat higher. Although the development of these plates was initiated to find a substitute for the tuning forks used with the 4-kc basic frequency supply for broad-band carrier systems, they have also proved very useful in many war projects, and will find increasing employment in peacetime communication circuits as elements of filters as well as of low-frequency oscillators.

Low-resonance frequency, which characterizes the duplex plate, results from using the lowest natural flexure frequency of a free bar which might be designated as edge flexure. Such a vibration is of the type indicated, greatly exaggerated, in Figure 1, where the nodal lines are at a distance of 0.224 times the length of the bar from the two ends. If a +5-degree X-cut quartz plate 50 mm long, 10 mm wide and 0.5 mm thick were suspended from its nodes by fine wire, a vibration of this type could be induced by tapping the plate at the center of one of its major faces. For such a plate, the resonance frequency of this type of vibration would be about 1,300 cycles.



The next lowest fundamental frequency of such a plate would be a face flexure. It could be induced by tapping the crystal at the center of one of the edge surfaces, and its resonance frequency would be about 20 kc.

If, finally, the plate were tapped at the end surfaces so as to set up a longitudinal vibration, the frequency would be in the neighborhood of 56 kc.

Both the face flexure and the longitudinal vibration have been utilized in quartz plates for a long time, the oscillations, of course, being excited piezo-electrically* rather than mechanically. Suppose, for example, that the crystal described above were plated with silver on both major faces as is common practice, and that a voltage were applied across them. Depending on which face is positive, the plate will either expand or contract longitudinally. If the voltage were alternating at about 56 kc, a resonant longitudinal vibration would be set up.

Now suppose the plate on each face were divided longitudinally by a central line, and that the diagonally opposite plated surfaces were connected together electrically. If an alternating voltage of the proper frequency were then applied to the two pairs of sur-

*RECORD, *February*, 1944, *page* 282.

faces, a face flexural resonance would be excited at about 20 kc.

Although both these types of vibrations may be readily induced piezo-electrically, there is no way of producing a flexural vibration of the type of Figure 1 in a single plate. Suppose, however, that two plates of the length and breadth of the one considered above but of only half the thickness be bonded together face to face with a very thin metallic layer, and that a voltage is applied across the outer faces of the bonded pair. It will be assumed first that the crystals are bonded with like faces together. Then the voltage applied across the plate will make one plate expand and the other contract. This will result in a bending as indicated by the dash lines of Figure 1. When an alternating voltage is applied across the plate, the crystal will vibrate in flexure at a resonance frequency of approximately 1,300 cycles per second.

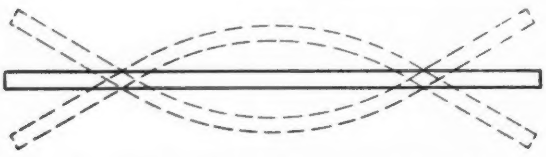


Fig. 1—The type of vibration of the duplex crystal. The distance of the nodes, or lines of zero vibration, from the ends of the bar is 0.224 times the overall length of the plate

This type of vibration may also be obtained by bonding the plates with unlike faces together, that is, a positive to a negative face. When this is done, one terminal of the supply voltage is connected to the bonding layer, and the other to both of the outer surfaces of the plates.

Although duplex plates may be made from any type of cut that will vibrate longitudinally, the best results have been obtained with +5-degree X-cut plates having a small width-to-length ratio. Such plates vibrating longitudinally have a low frequency-temperature coefficient, and duplex plates that have been made from them have a similar and much lower characteristic.

Quartz crystals may be either right-handed or left-handed—the term implying an opposition between certain characteristics much as exists between the fingers of the two hands. Either type may be used for making duplex crystals; both of the component plates may be of the same handedness or one may be right-handed and the other left. There will be a slight difference in the temperature coefficient, however, depending on the combination of handedness and poling employed. When the plates are poled in opposite directions, that is, like faces together, the best temperature coefficient is obtained when one plate is left-handed and the other right. When the plates are similarly poled, however, the best coefficient is obtained by using plates of the same handedness.

There is another characteristic of the duplex plates that is affected by the combination of handedness and poling. When a single +5-degree X-cut plate is made to vibrate in flexure as in Figure 1, the two nodal lines do not run perpendicularly across the plate but at an angle of about 11 degrees with the perpendicular to the sides. The reason for this is that quartz has different Young's moduli of elasticity depending upon direction taken, and that the directions for maximum and minimum are

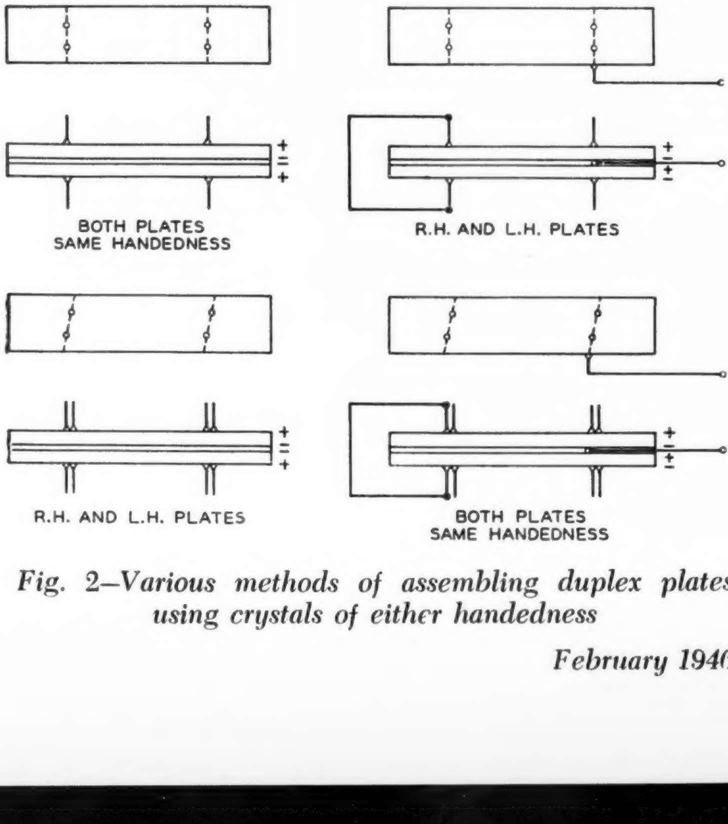


Fig. 2—Various methods of assembling duplex plates using crystals of either handedness

not coincident with the directions of length and width of the plate. In a +5-degree plate the direction of minimum makes an angle of about 23 degrees with the length direction of the plate. In quartz plates of opposite handedness, the nodes slope to opposite sides of the perpendicular when both plates are looked at from faces of the same polarity. When the two plates of the same handedness are similarly poled, therefore, or when two plates of opposite handedness are oppositely poled, the nodes for the two plates will line up, and the node for the combined duplex plate will correspond to that of each plate individually.

When two plates of the same handedness are oppositely poled, or when two plates of opposite handedness are similarly poled, the node of one plate lies to one side of the perpendicular, and that of the other to the other side. The node for the combined duplex plate will then lie halfway between the nodes for the individual plates, and will therefore be perpendicular to the side of the plate.

These various ways of forming duplex plates, and the position of their nodes, is indicated in Figure 2. The two lower plates, with their nodes running across the plate at an 11-degree angle, have somewhat the better temperature coefficient.

Two quartz plates that are to form a duplex crystal are first sprayed with a silver paste on the sides that will be bonded, and then baked at a high temperature to fix the paste firmly to the quartz. After this, the silver is burnished and then tinned. The two tinned surfaces are then pressed together with sufficient pressure to force out all excess solder. The resulting film holding the plates together is only about 0.02 mil thick. This thin layer of solder has negligible effect on the performance of the plate since it is located at the neutral plane where there is zero compression and elongation. The outer surfaces are coated with evaporated silver as with other types of crystals. Duplex crystals are supported by fine wires attached to the face along the nodes, as are other type crystals as already described in the RECORD.* When a connection is to be made to the bonding layer, a narrow strip of silver coating is extended from one of the supporting wires over the edge of the plate to the bonding layer. This connection is then isolated electrically from the rest of the plating on the surface by fine dividing lines.

The duplex crystal, as is true of other types of crystals, is electrically equivalent to an inductance and a capacitance in series shunted by a second capacitance. To realize a good "Q" for the duplex crystal, it is essential that it be mounted in a vacuum. Photographs of such a completed unit are shown at the head of this article. When this is done, "Q's" as high as 25,000 or 30,000

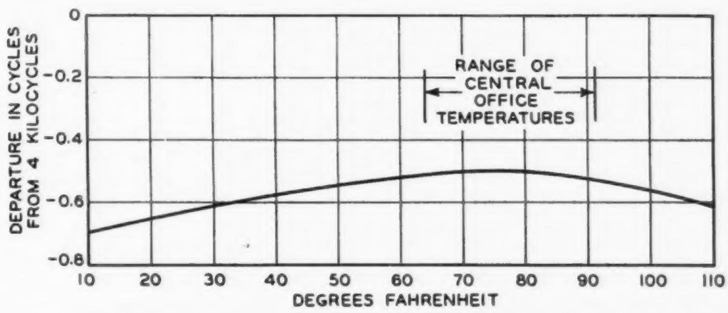
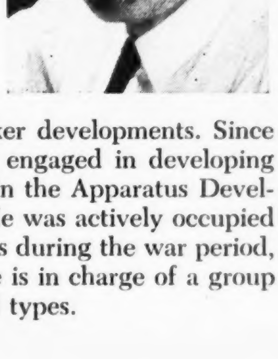


Fig. 3—Temperature-frequency characteristic of a 4-kc duplex plate used with carrier telephone systems

THE AUTHOR: C. E. LANE received an A.B. degree from the University of Iowa in 1920 and an M.S. degree from the same university in 1921. He then joined the Engineering Department of the Western Electric Company, now Bell Telephone Laboratories, spending his first five years in the Research Department engaged in general studies pertaining to speech, hearing, and loudspeaker developments. Since that time he has been engaged in developing transmission networks in the Apparatus Development Department. He was actively occupied with filter developments during the war period, and at the present time is in charge of a group developing filters of all types.



*RECORD, *April*, 1945, *page* 140.

are readily obtainable. The ratio of the direct capacity of the duplex crystal to the capacity in the series resonant arm of the equivalent circuit is about 200, which is indicative of a fair electro-mechanical coupling. This ratio for a +5-degree X-cut crystal of the longitudinal type is about 120.

In using duplex crystals in oscillators, no connection is ordinarily made to the inner electrode. For filters, however, there is a decided advantage in using the bonding layer as one of the electrodes, since the impedance of the plate is then only one-fourth as great as when the connections are made to the outer surfaces.

A typical temperature-frequency characteristic of a duplex crystal is given in Figure 3, which shows the relationship for a 4-kc crystal used for carrier telephone systems. Duplex crystals of other frequencies differ very little in temperature coefficient from this. Over the ordinary range of temperature encountered in a central telephone office, such a crystal does not depart by more than about 0.02 cycle from the frequency at mid-temperature.

Mobile Service for Inter-City Highways

The Bell System has announced plans for extensive service trials of mobile radio-telephone service along three inter-city highway routes totaling nearly 1,000 miles. The routes are those between Chicago and St. Louis; between New York, Albany and Buffalo; and between New York and Boston.

When these services are established, it will be possible for any suitably equipped vehicle on the highways along these routes or any boat on adjacent waterways to make and receive calls to or from any telephone connected to lines of the Bell System. Transmitting and receiving stations required to provide the two-way voice communication service will be located along the routes.

Applications for authorization to establish the first stations to serve the Chicago-St. Louis route have already been filed with the Federal Communications Commission by the Illinois Bell Telephone Company. It is expected that applications for the other routes will be made soon. However, operation of the new service will not begin until several months after the FCC has authorized construction.

Highway mobile radio-telephone service will operate like this:

Calls will be handled by mobile service telephone operators. The conversations will travel part of the way by telephone wire and part of the way by radio. If a caller in Chicago wants to talk to the occupant of a certain automobile somewhere between Chicago and St. Louis, he will first reach "Long Distance," ask for the mobile service operator, and give her the call number of the vehicle. She will route the call over telephone wires to one of the transmitting-receiving stations along the highway, which sends the signal on to the vehicle by radio. The car occupant will receive an audible and visual signal indicating that he is wanted. He then will pick up his dashboard telephone and answer. Under his fingers as he holds the telephone handset will be a "push-to-talk" button which will permit him to switch from listening to talking.

The occupant of a mobile unit will be able to originate calls merely by picking up his telephone, listening to make sure the circuit is not in use, and pushing the "talk" button. This will signal the mobile service operator and she will "come in on the line." He will give her the telephone number he wants and the call will go through.

Plans for Bell System mobile radio-telephone service on inter-city routes are extensions of plans announced previously for urban mobile service. Substantial progress has already been made in the program for establishing radio-telephone stations in certain cities to provide urban service to vehicles, including trucks, cars, and boats, within and immediately around those localities. To date, FCC approval has been obtained for experimental installations in 20 cities and applications also have been filed or are under preparation for stations in thirty-two other cities.

Bell Telephone Laboratories Books

Theory of Vibrating Systems and Sound				*Irving B. Crandall*
	1926	282 pages	$5.00	
Transmission Circuits for Telephonic Communication				*K. S. Johnson*
	1927	334 pages	$5.00	
Probability and Its Engineering Uses				*Thornton C. Fry*
	1928	483 pages	$7.50	
Elementary Differential Equations				*Thornton C. Fry*
	1929	255 pages	$2.75	
Speech and Hearing				*Harvey Fletcher*
	1929	331 pages	$5.50	
Transmission Networks and Wave Filters				*T. E. Shea*
	1929	512 pages	$6.50	
Economic Control of Quality of Manufactured Product				*W. A. Shewhart*
	1931	501 pages	$6.50	
Introduction to Contemporary Physics (Second Edition)				*Karl K. Darrow*
	1939	646 pages	$7.00	
Rhombic Antenna Design				*A. E. Harper*
	1941	111 pages	$4.00	
Electromechanical Transducers and Wave Filters				*Warren P. Mason*
	1942	333 pages	$5.00	
Electromagnetic Waves				*S. A. Schelkunoff*
	1943	530 pages	$7.50	
Fundamental Theory of Servomechanisms				*LeRoy A. MacColl*
	1945	128 pages	$2.25	
Network Analysis and Feedback Amplifier Design				*Hendrik W. Bode*
	1945	556 pages	$7.50	

All of the volumes are illustrated as required, are bound in cloth and measure 6¼ inches x 9¼ inches with the exception of Rhombic Antenna Design, which is 8¼ inches x 11¼ inches. They are published by D. Van Nostrand Company.

Forthcoming Publications

Visible Speech	*R. K. Potter*
Quartz Crystals	*R. A. Heising*

Scientific and Engineering Texts

TWENTY years have passed since the first book in the Bell Telephone Laboratories Series was published; during that time thirteen volumes have appeared and several others are to follow in the near future. It is a great satisfaction to members of the Laboratories to know that these books have been widely distributed among fellow-scientists, and to feel that they have made a real contribution to a broad field of technology.

The first books grew out of classroom lectures prepared by Laboratories specialists to provide information not available in the existing literature. While this information applied primarily to problems of telephone transmission, the art of electrical communication involves practically every branch of science, and the usefulness of the Series is by no means confined to telephone engineers. At least half the titles are of broad general interest and even those that seem most closely related to the specialized techniques of telephone transmission are of equal importance to students of radio and television, and to the many scientists who have been engaged in wartime studies of detection and fire control.

Of the Series as a whole it should be added that all the books have been written by men who have a long background of practice as well as theory. They are members of an industrial research organization whose efforts are measured in terms of economy and efficiency of world-wide telephone service.

Bell Telephone Laboratories as an organization is very conscious of the social obligation described by Mr. Mills, who until his recent retirement exerted a guiding influence over the Series from its beginning. All of the books—those to come as well as those already issued—are dedicated to our fellow-scientists throughout the world, with the hope that they may profit from our knowledge and experience as we have profited from theirs.

R. K. HONAMAN.

THAT the modern marvels of technology are pyramids on the firm base of science all will admit and none more readily than the productive workers in the various engineering arts. They know that their arts, whether chemical, electrical or mechanical, rise upon a body of scientific knowledge to which millions of workers have contributed throughout the ages, but with better organized effort and at an accelerated pace in more recent days. The startling progress of technology during recent decades has resulted in part from the large number of well-trained workers which its own successes have attracted but in largest part from the constantly increasing breadth and depth of the foundation.

Each of the technological arts, therefore, has a social obligation—reënforced by enlightened selfishness—to contribute to the common foundation as much and as promptly as it can from its own special store of knowledge, and to make available appliances and techniques which would be useful to other scientific workers. This has been recognized most fully, probably, by the electrical arts and, perhaps, by none more wholeheartedly than the art of electrical communication. Alexander Graham Bell, for example, the founder and first research worker of the Bell Telephone System, early expressed his dependence upon the organized body of knowledge which is science. (On the other hand, he may have profited from the current lack of knowledge as to the complexity, transient character and feeble acoustic power of the sound wave of a spoken word, for if he had known these magnitudes, measured by his successors, he might well have despaired of his appointed task.)

The program of research, invention and development which he initiated has continued ever since; but it was not until about 1911 that the research work of the Bell System was coördinated in a department under that title. At that time the laboratories he had founded were operated by the Engi-

neering Department of the Western Electric Company, the manufacturing unit of the Bell System. This coördination came about under the direction of Dr. Frank B. Jewett; and there then evolved a policy of helpful publication.

The Research Department was then starting its work in what we know today as electronics and most of its publications were in that field. They appeared as contributions to the periodicals of appropriate professional societies. At that time scientists, although interested in the emission of electrons, were relatively little interested in the application of the Laboratories' electron tube—the high-vacuum successor of the DeForest audion—to circuits for electrical communication, whether by wire or by radio. Only gradually, therefore, did they sense the possibilities of that amplifier and of the related device, the photo-electric tube, as measuring equipment in the experiments of pure science.

In Bell Telephone Laboratories, on the other hand, all the different forms of electrical communication were proceeding apace. There were, however, no text books adequate to the needs of its workers; at that time engineering schools and universities gave no courses on electron devices and electrical networks. Because there was need for a further training of the young Ph.D.'s and bachelor graduates whom the Laboratories employed, there was set up, largely under the guidance of George B. Thomas, Personnel Director, an ingenious arrangement. "Out-of-hour courses" were organized in the hours immediately preceding or following regularly scheduled work. These were open to enrollment by members of the Laboratories' technical staff. The instructors were other members of the technical staff, recognized as experts in their particular fields, who volunteered or, as sometimes happened in the early years, were persuaded. Each instructor prepared an outline of notes which was then mimeographed and given to his students.

Although the class presentation of the material, like the attendance of the students, was an out-of-hour activity, the preparation of the material was recognized as valuable not only to the instructor but even more to the Laboratories as a corporation. Making a logical survey of an entire field frequently led the author into new territory; and the expense of the work, including that of assistants who plotted new curves or performed new experiments, was never a controlling factor in the face of the overall value. Usually each year a new edition of the notes would be mimeographed, representing the growth of the art and the new material of the instructor or the extensions of a succeeding instructor. The art, the instructors and the students all developed in an atmosphere favorable to growth.

These volumes of notes were in effect up-to-date treatises on certain phases of the expanding art of electrical communication or on related portions of science and mathematics. They had, or so it early appeared to the present writer, a function in the Laboratories' policy of contributing to the base upon which it pyramided the structure of its own art. As such several of them should form part of the current technical literature for all interested scientists. They should, in other words, be made available in book stores and through the usual channels of technical publication.

An opportunity for this new step in publication came with an invitation from Harvard University to Kenneth S. Johnson, who for years had carried the Laboratories out-of-hour course on telephone transmission. He was asked by Professor A. E. Kennelly, who was arranging for a sabbatical year of absence, to present this material to one of his classes. The course was given; and the class was supplied with mimeographed notes from the Laboratories. The reception of the material indicated that the notes would be welcomed in other universities in their departments of electrical engineering; and it therefore seemed opportune to put them in the form of a printed book.

Since the text prepared by Mr. Johnson was only one of several which might be so released for wide dissemination, and other texts would undoubtedly develop in the future, it seemed desirable to initiate a Bell Laboratories Series. For imprint the Laboratories then selected the D. Van Nostrand Company, Inc., of New York.

John Mills.

The School for War Training

By PAYTON W. SPENCE
Registrar

WORLD WAR II began on a higher technical level than any previous war, and the level was being rapidly raised by radically new, very complicated electronic devices by the time we actively entered it. Shortly after Pearl Harbor it became apparent to the leaders of our Armed Forces that large numbers of men would have to be trained quickly and effectively in the operation and maintenance of the many new types of apparatus that would soon be available for military use. The School for War Training of Bell Telephone Laboratories was born out of this need. Originally it was thought that the School would train only key personnel, who would then continue the training work on an enlarged basis within schools of the Armed Forces themselves. There was an immediate need for maintenance personnel as well as for teachers, however, and so the Laboratories' School almost at once had to undertake both types of instruction. It did both jobs to the end, but the emphasis was placed primarily on training key personnel for the Armed Forces.

Opening on April 27, 1942, the first class

The photograph above shows a scene at graduation. E. J. Thielen presents a diploma to a Navy officer; Mr. Spence is shown seated at the table.

was composed of radio repairmen, many of whom had only a few weeks before operated their own radio repair shops, civilian engineers, and engineering officers of the Army Signal Corps, who had already completed several months of training at the Radar School of the Massachusetts Institute of Technology. The radio repairmen were to be trained for assignment to Signal Corps Depots for repairing airborne equipment, mostly radar, of which delivery in quantities was to begin within a few weeks after that date. The engineers, both civilians and officers, were being prepared for assignment to key positions in training centers where they were to establish training programs on the same and similar equipment directly under Army auspices. Six weeks were allowed for initiating all these men in the new art of radar.

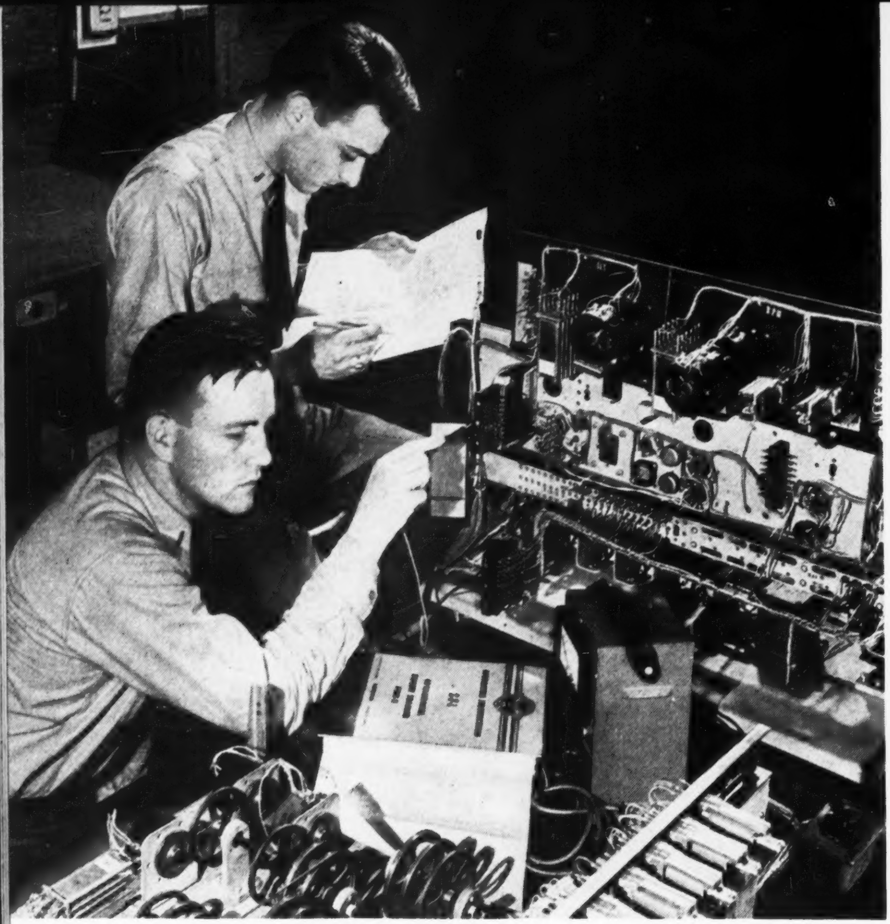
Within three weeks after the opening day, a second class was sent, also from the Signal Corps, and of approximately the same composition as the first class. Two more weeks passed and the Naval Research Laboratories sent a group of its engineers for training in the equipment being used for the Army courses. In five weeks after launching, there were thus three classes in session, and the Army and Navy were both represented.

The Signal Corps contract grew into a long-term relationship which continued into a third year. During that time the activities originally under Signal Corps jurisdiction were transferred to the Army Air Forces, but the training activities were continued on the newer radars as fast as they were put into production.

In the meantime, other branches of the Army requested training in electronic equipment. Modern tank warfare required radio communication between tanks, between tanks and their commanders, and between personnel within tanks themselves. A new kind of radio had been developed that was more complicated than any heretofore developed except for long-range communication, and an advanced grade radio repairman was required for its maintenance. The equipments were coming off the lines and being installed in tanks as rapidly as possible for the African theater. Since the Signal Corps was not prepared to train as many experts as were required on the fighting fronts for the initial deliveries, the School was asked to take on the training of three classes, each well over one hundred officers and enlisted men. The enlisted men were to carry on the actual physical maintenance of the equipment at the fighting fronts, while the officers were to supervise maintenance depots and maintenance training centers.

With the development of the electrical director by the Laboratories, there was available to the Armed Forces another electronic device that had all the aspects of a maintenance headache. Ordnance personnel were intimately familiar with mechanical directors, but had little or no experience with devices employing vacuum tubes and the other special electrical units used in the electrical director. The Ordnance Department came to the sources for training, and the School for War Training was asked to train maintenance personnel and teachers for this new art. The Anti-Aircraft branches of the

A laboratory scene—T. C. Bassett, one of the instructors, supervises measurements on a breadboard layout



Trouble-shooting on a mock-up component of the crew flight trainer

fifteen to thirty such officers to the School each month from the middle of 1943 until the autumn of 1945 for six weeks of training. We have been told that it became an established policy of the Navy to assign at least one officer trained at the Bell Laboratories School to each major ship—battleships, carriers, and cruisers—and as far as possible to carry this policy to the smaller ships having radar fire-control equipment aboard.

The staff of the School had been selected mostly from the members of the Technical Staff of Bell Laboratories and from engineers lent to the Laboratories by the Associated Telephone Companies, most of whom had from fifteen to twenty-five years of experience as telephone engineers. Most of the men selected for the School's work had never had any teaching experience. By selecting articulate men and by defining the objectives to them individually and in conference, it was possible to convert some of the best development engineers into unusually competent and sympathetic teachers.

Army also asked for special training in the Laboratories for its personnel. These classes included officers, enlisted men, and civil service employees. Since the British were also purchasing large numbers of these directors, they sent about fifteen of their key personnel to these classes, all of them commissioned and non-commissioned officers who later continued the training for the British Army in England.

During the second year of the School's operation, a relationship was established which continued until after the final close of the war. The Bureau of Ordnance of the Navy Department and the Bureau of Naval Personnel asked the School to undertake advanced training for key officers in radar fire-control equipment. This training was to follow training of six months to a year in radio, radar, and other electronic techniques at several universities, including Bowdoin, Harvard, and Princeton, as well as advanced training at the Massachusetts Institute of Technology. Provision was also made for refresher training for radar officers who had had experience at sea. The Navy sent from

Only men who would have an all-out devotion to the work were selected. In the early days of the School, the only set hours were those when classes met; the rest of the day, and sometimes too much of the night, was used by the staff in preparing their future work. Several of the staff took rooms in town so as to be able to devote more hours to the work. The staff became so fascinated with the new devices, and with their new experience in dealing with large groups of alert men and women, that hours, no matter how long, ceased to be considered. This devotion, so important to the success of the School, was undoubtedly also a big factor in the success of much of the Laboratories' war work.

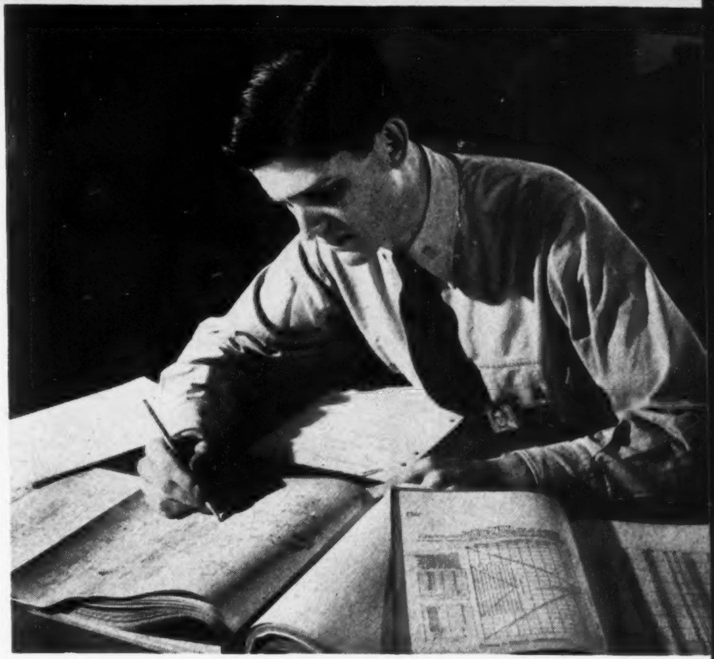
All the courses assumed a certain amount of background in the elementary electricity and electronics that would be required for

maintaining a broadcast radio receiving system, but for most of the classes it was necessary to give basic instruction in the principles of operation of the new devices. For a six-week course this fundamental work might take five to eight days.

Laboratory work was carried on in groups of two except in rare cases. From 55 to 75 per cent of the total course time was consumed in laboratory work. As soon as the students were ready, they were introduced to the particular equipment on which training was to be based. Laboratory work on the complete equipment under normal and satisfactory operating conditions was followed by further work on disabled components and disabled equipment. Troubles were actually put into these equipments. They were synthetic, of course, but always illustrated troubles that might occur in operation and, more important, they required for their detection a trouble-shooting technique developed during the course. The Armed Forces coöperated with the School in furnishing the maximum equipment that could be spared for this training. They became aware early in the training programs that only by the manipulation of equipment could adequate training be accomplished.

An important factor in gaining the confidence of the students and carrying them through to successful completion of their work was the close coöperation between staff and students. The students were always made aware that the staff was ready and willing at all times to talk to them individually and collectively—either during or out of normal hours. The School was open for eight hours each day from Monday through Saturday, and until 9 o'clock each evening from Monday through Friday, when the instructing staff was prepared to give individual instruction to those students who required it. The staff were glad to establish these individual contacts since besides helping the students, they revealed information which led to improvement in training techniques for future classes. This open-mindedness of the teaching and administration personnel who were associated with the School was one of the most important factors in its success.

Over the more than three years of the School's life, a total of 4,400 students were enrolled. Of these, about 4,200 were assigned from the Armed Forces, including the Army, Navy, Marine Corps, and a few from the Merchant Marine. The other students were members of the Western Electric Company and Bell Laboratories. The division of the students is roughly half civil service employees of the Armed Forces and half officers and enlisted men. Nearly 80 per cent of the students were from the Army and the remainder from the Navy. The total number of courses was 125, of which four were for members of the Western Electric Company and Bell Laboratories. A number of Navy officers were also



Examination time

Scene in classified book vault. A Navy officer signs for books received from Mrs. A. M. Lewis

Mrs. E. P. Rohde assists a Navy officer to register

class displayed a good grasp of the subject. In addition, it was found that each time they described features of the work, they became more competent to carry on the next job, and gained a self-assurance which was reflected in their improved trouble-shooting abilities.

All of the work of the School and all of the texts and apparatus it dealt with were classified as confidential or higher.

assigned to a total of eleven refresher courses, which were in the nature of tutoring courses. The maximum enrollment at any given time was just over 350 students. Most of the courses were of six weeks' duration, although some were as long as eighteen weeks and a few as short as two or three weeks.

Scheduling of this work took considerable time and ingenuity because of the limited equipment and space, and the small size of the laboratory groups. Study periods were avoided. Activities were scheduled for all students for the whole of each week of forty-eight school hours, and were published from one to three weeks in advance. Students requiring special assistance were asked to come at night so as not to interrupt their regular program. Experience indicated that a large majority of the students were not prepared to study in an organized fashion, and that the work had to be presented by lectures, tutoring, and through laboratory experience.

A new teaching technique was developed that has worked very satisfactorily. For lack of a better name, it has been called a "conference quiz." For this work, the student body was divided into groups of from five to ten men each, and these groups would sit around a table and discuss the work under the instructor's leadership. In these small groups, many students who might not express themselves competently in a large

Every possible precaution was taken. Students were properly certified by the Armed Forces and adequate steps were taken to insure that no apparatus or descriptive material left the premises except under authorized regulations and that no unauthorized persons gained access to them. This applied even to the Laboratories' personnel. Ten courses in one project, which was "top secret" then and still remains so, were carried on with none of the instructors or students except those involved in the courses ever knowing that they were in progress.

The School was organized by R. K. Honaman and was directed by him until May, 1945, when he began to devote his entire time to the Publication Department. From then until its termination in September, 1945, it was under the directorship of M. B. McDavitt and A. Tradup. The general administration was carried on by E. J. Thielen, Assistant Director of the School, and by the author. General supervision of the teaching was handled by J. Meszar and R. N. Hunter, with the help of several others during the periods of greatest enrollment. All contractual arrangements between the School and the Armed Forces were handled by the radio division of the Western Electric Company. The students remember best Mrs. E. P. Rohde, who registered them in the school and assisted them with personal problems, such as arranging for satisfactory housing during

their stay in the New York area. Mrs. Rohde probably has had the largest fan mail of anyone in the School. During the period of maximum registration, the staff consisted of about seventy-five engineers and about twenty people for administration.

It was necessary to prepare most of the text material used in the courses. Some of this was in a form that could be applied as temporary instruction books for the services, while other books were written solely for instructional purposes. One book, known as WTB-1 and entitled *Review of Fundamental Electrical Principles,* was given to each student of the School. It was designed as a refresher for the men after they have had instruction at other schools. This book has been printed in four editions to a total of several thousand copies. The Bureau of Ships of the Navy Department, with Laboratories permission, reprinted the book and used it in Navy training activities. A total of about 20,000 copies were made by the Navy Department. The number of instruction books prepared for School purposes had passed the fifty mark when preparation of books specifically for such purposes was discontinued.

Preparation of operating and maintenance books was a natural for the staff, since as a result of their contact teaching, they had become aware of techniques in presentation that could be applied to these books. It was partly as a result of this that the staff was asked to take on preparation of some of the instruction books for Army and Navy contracts, an activity which continued to the closing of the School, and became one of the principal activities of its staff. Arrangements for enabling students to obtain credit in colleges for work done at the Laboratories' School for War Training are being completed by the American Council in Education on the basis of summaries of the courses prepared by the School's staff.

THE AUTHOR: PAYTON W. SPENCE joined the Engineering Department of the American Telephone and Telegraph Company in 1914 and worked for a year on safety codes. He then severed his connection with the company temporarily to study at Columbia University where he received the B.S. degree in 1918 and that of E.E. in 1921. In the same year he returned to the A T & T and engaged in studies of inductive interference in the Long Lines Department. From 1922 to 1927 he was with the Operations Department, working on problems in broadcasting development, new services, and patent licensing. For some years after 1927, with the D & R, which merged with the Laboratories in 1934, he was occupied with studies of the effect of electric shock; and later spent a number of years in protective studies of carrier telegraph circuits. Mr. Spence was also active in committee work on the National Electrical Code and the National Safety Code. In 1942 he took an active part in organizing the School for War Training, and acted as Registrar until the School was finally closed.

A lineman uses a "hot stick" to connect a coupler for high-frequency telephone carrier

First Call Made Over New Rural Power-Line Carrier

Jonesboro, Ark., Dec. 17.—Gordon Nelms, general storekeeper at Brookland, this morning picked up his telephone to make a call, and his message, instead of traveling over conventional telephone wires, "hitch-hiked" a ride over rural electric power lines to its destination at a farm neighbor's home.

Nelms' call marked the first public use of a rural power-line carrier telephone system in a test arranged coöperatively by Bell System and Rural Electrification Administration engineers. They hope the experiment will demonstrate the feasibility of extending telephone service by this method in areas where farms are located at a considerable distance from telephone lines but are served by power lines.

The trial is a joint undertaking of Bell Telephone Laboratories, the REA, the Southwestern Bell Telephone Company, and the Craighead Electric Coöperative. It is another step in a series of tests* which were started some years before the war and which have recently been resumed.

To extend telephone service to the largest number of rural families in the shortest time, the Bell System plans to make full use

*Record, *February*, 1943, *page* 145.

Below, left—J. W. Emling (right) of the Laboratories explains an experimental power-line carrier telephone set to T. A. Taylor of the A T & T. Below, right—U. S. Ford of the Laboratories and L. W. Cloyd of the Southwestern Bell record readings of sensitive instruments at the point where power lines of the Craighead Electric Coöperative join telephone lines of the Southwestern Bell Telephone Company just outside Jonesboro, Ark.

of a variety of new methods and materials which have been developed to improve service and to increase speed and economy in extending it. Although many new farm telephones will be served by regular telephone wire lines, it may be found more economical in many areas to make use of power-line carrier than to extend wire telephone lines, and, in a few remote locations, radio-telephone systems may be best. Local conditions will determine the kind of system to use, and field tests and further experimentation must continue for a considerable period before commercial application can be made.

In outward appearance, the equipment in the home is much like that used on other telephone lines. A small box containing electronic tubes not unlike those used in a table radio produces a high-frequency current which carries the telephone conversation over the power wires. A device known as a "coupler," located on the pole outside the customer's house, allows this carrier current to enter or leave the power lines but prevents the power current from entering the telephone instrument. Thus the new power-line instrument is as safe to use as the regular telephone instrument. Somewhat similar equipment is located at the telephone central office end of the power line. Over such a system a person can call anyone on his line, on another carrier system, or on any telephone line. The apparatus used for this trial is of tentative design, but under the direction of P. W. Blye and J. M. Barstow, commercial development of all components of the rural carrier system is being rapidly advanced.

William Hickox of the Southwestern Bell Telephone Company, George Dodrill (pointing), engineer of the Rural Electrification Administration, J. M. Dunham of Bell Telephone Laboratories, and Vernon Smith of the Craighead Electric Coöperative discuss the pole insulation job

Reorganization of FCC Engineering Department

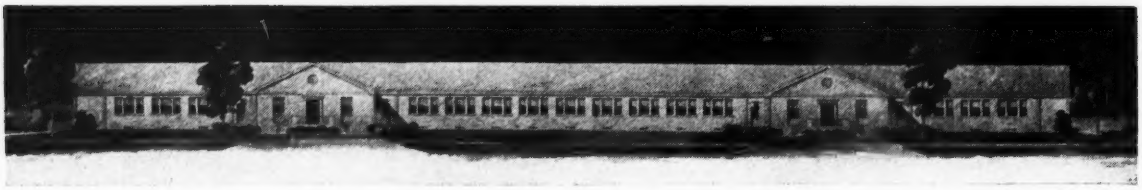
As a step toward expediting the handling of its sharply increased post-war work load, the Federal Communications Commission on November 28 ordered a reorganization of the Engineering Department. The Broadcast Division is to be renamed the Broadcast Branch and will be headed by John A. Willoughby, who has been assistant chief engineer in charge of the Broadcast Division.

The Broadcast Branch will consist of three Divisions as follows: Standard Broadcast Division, James A. Barr, acting chief; FM Division, Cyril M. Braum, acting chief; and Television Division, Curtis B. Plummer, acting chief.

There are to be three other branches of the Engineering Department: Safety and Special Services Branch consisting of the Marine and General Mobile, Aviation, Emergency and Miscellaneous Divisions; Field and Research Branch, consisting of the Field and Monitoring, Technical Information, Frequency Allocation, and Laboratory Divisions; and the Common Carrier Branch consisting of the Domestic, International, Rate, and Field Divisions.

Christmas Telephone Traffic

On Christmas Day telephone toll board calls averaged 11 per cent higher than the year before, compared with 20 per cent for current business day traffic, the O & E reports. Changes in volume ranged from an increase of 52 per cent in Omaha to a decrease of 10 per cent in Washington, D. C.



The Whippany Radio Laboratory

In reconverting to peacetime operations at the Whippany Radio Laboratory it is planned to consolidate the Commercial Products Development Department at this location. This will permit the vacating of the space now occupied by the Department in the Graybar-Varick building and the abandonment of the Highlands Laboratory. During the war the Whippany Radio Laboratory staff was completely engaged in the development of radar equipment for the Army and the Navy. The development of military projects for the United States Government will in peacetime represent a major portion of the activities of the Department. The remaining activities of the Department will be devoted to the development of radio equipment for the use of the Bell System and for use in fields outside of the Bell System as, for example, radio-telephone, broadcasting, television, radio communication for mobile purposes and the like.

A careful analysis of the peacetime program has been made in respect to space requirements from which it has been determined that additional office and laboratory space of a permanent character will be required. The peak wartime population at Whippany was approximately 650 people, and it is expected that, when the peacetime development program has been established and groups now housed elsewhere are consolidated there, the population will be something of this same order. While the total population in wartime and in peacetime will not be appreciably different, the increase in space is made necessary by the fact that the technical force is greater and the service force less, thereby requiring more laboratory space, which space is further increased by the character of the jobs in the military program and in the fields of broadcasting and television.

After carefully surveying types and locations of structures that might be added to provide the needed space and be in keeping with the existing permanent types of structures, it has been concluded that the new space can best be provided by an extension to the present Administration Building. This extension will be one story and basement and the exterior dimensions except for length will be identical with the present structure. The addition will be 211 feet long, whereas the length of the present building is 183 feet, making the overall length of the building when completed 394 feet; the width of the main building and front wings is 45 feet. The architect's conception of the building is shown above.

Occupancy of the building when the addition to it has been completed will remain the same insofar as the front wing is concerned, that being devoted to executive offices and a conference room. The restaurant and lounge will continue in their present location. The remainder of the space in the building will be devoted exclusively to the development of military projects. Authorization for the additional space was approved by the Board of Directors of the Laboratories at its meeting which was held on December 20. It is planned that work will begin with good weather in the spring and it is hoped to have the addition completed ready for occupancy by Sept. 1, 1946.

War Service Certificates

In commemoration of the conclusion of World War II, and in recognition of contributions to victory made by individuals through their work in Bell Telephone Laboratories, appropriately inscribed War Service Certificates have been distributed to all present and former members who, between December 7, 1941, and August 31, 1945, served for one year or more.

Legion of Merit Awards

FOR outstanding services during World War II, four members of the Laboratories on military leaves of absence have been awarded the Legion of Merit:

COLONEL HIRAM B. ELY, for service with the Ordnance Department as Chief of the Field Service Sub-Office, Frankford Arsenal.

COLONEL MORTON SULTZER, as Signal Corps Stock Controller, Chief, Stock Control Division, Storage and Issue Agency, and later as Commanding Officer, Sacramento Signal Depot.

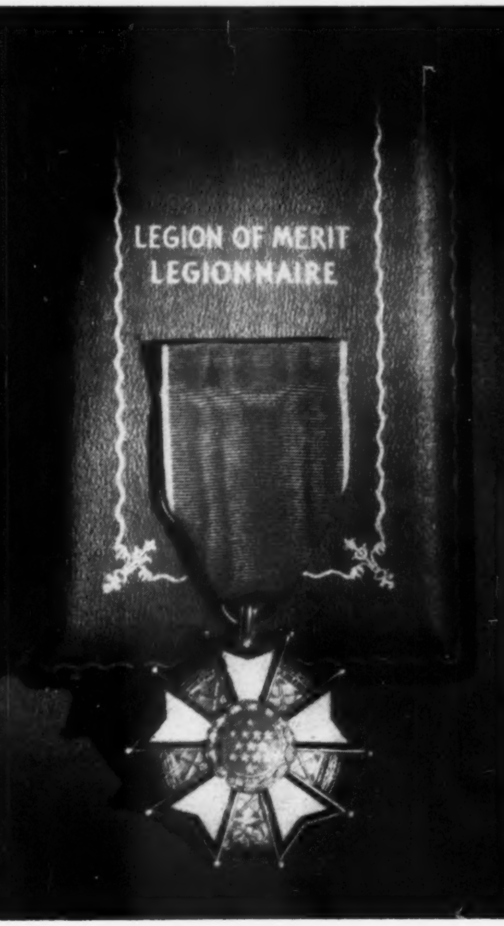
LIEUT. COL. CHARLES H. GREENALL, Ordnance Department, as Officer-in-Charge, Laboratory Division, Frankford Arsenal.

LIEUT. COL. FRANK A. PARSONS, as Assistant Ammunition Officer and Ammunition Officer, Ordnance Section, Headquarters, Twelfth Army Group.

Citations accompanying the awards are as follows:

Colonel Hiram B. Ely

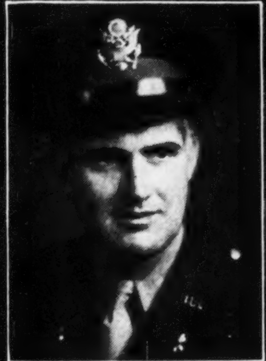
"By application of effective managerial ability, Colonel Ely established, and for two years directed, operations in an exceptionally meritorious manner and with a record of accomplishments which constituted a major contribution to the fulfillment of the overall mission of the Ordnance Department. His office served as a centralized agency for the effective coordination of all Field Service activities in connection with the supply and maintenance of Fire Control and Antiaircraft Artillery matériel. Under his guidance and supervision, the Frankford Ordnance Depot met with an unparalleled operating record—the challenge of a 1,000 per cent increase in business; the problems of maintenance and supply of new matériel were successfully handled; the supply publications



Colonel Sultzer


Colonel Ely


Lieut. Col. Parsons


Lieut. Col. Greenall

were revised and stock properly identified; and a central stock control office for Fire Control and Antiaircraft Artillery matériel was created."

Colonel Morton Sultzer

"During the time of Colonel Sultzer's assignment as Stock Controller, improvement was made in the total number of line items shipped from a depot upon receipt of requisitions. This increased efficiency reflected innovations which he was responsible in large measure for initiating in stock movement and distribution throughout the fourteen Signal Corps storage facilities in this country. Upon his assumption of the position of Chief, Stock Control Division, nearly 10 per cent of over 17,000 requisitions required five days' processing prior to release for shipment. He devised new procedures which accomplished processing of all but 3 per cent of 19,000 requisitions to permit release for shipment in the depot in less than four days. With the increased demands due to the emphasis given Pacific operations after V-E Day, Colonel Sultzer was made Commanding Officer, Sacramento Signal Depot, and was instrumental in establishing a steady flow of equipment to support the final victory of our Pacific fighting forces."

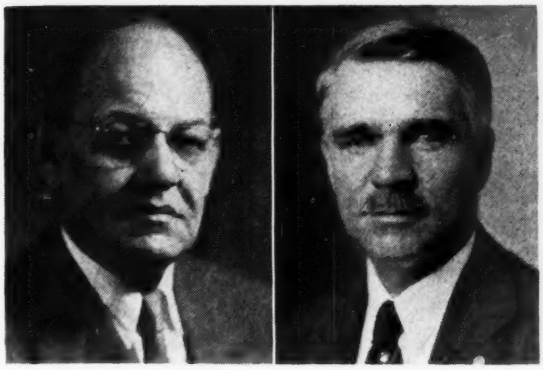
Lieut. Col. Charles H. Greenall

"Lieut. Col. Greenall's exceptional leadership and initiative in the revolutionary development of recoilless artillery made possible the production of weapons which had far-reaching results in the combined effectiveness of the Infantry and Artillery. Through his energy, enthusiasm, and sound technical judgment, these weapons were rapidly and successfully developed under conditions of severe pressure. Lieut. Col. Greenall's outstanding achievements in directing not only this, but a great number of other significant projects, contributed greatly to our success in the war. He demonstrated at all times an unswerving devotion to duty and his high qualities of leadership were an inspiration to those whose work he directed and supervised."

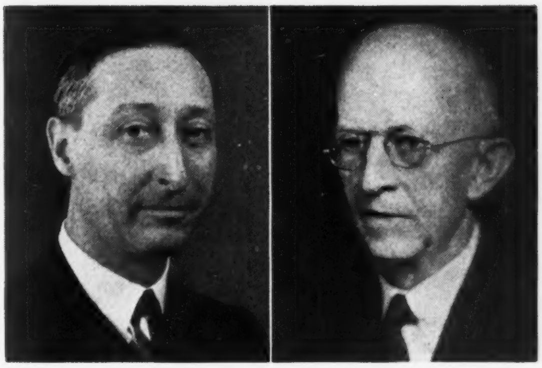
Lieut. Col. Frank A. Parsons

"Lieut. Col. Parsons displayed superior organizational ability, keen judgment and foresight in formulating plans, preparing ammunition requirement estimates, and insuring the expeditious flow of supplies to the combat armies. During the Ardennes breakthrough he immediately and efficiently provided the resupply of munitions to units which had been cut off from normal supply channels. Lieut. Col. Parsons' rapid perception and brilliant analyzation of the constantly changing supply situations contributed materially to the success of the war effort and reflect highest credit upon himself and the Armed Forces of the United States."

Approximately 120 members of the Systems Development Drafting Department honored eleven of their members with a dinner at Zimmerman's Hungaria as a climax to their 25th Bell System Service Anniversary. Seated, left to right: J. Filmore, A. G. Shepherd, A. W. Frey, E. W. Rahn and R. P. Yeaton. Standing, left to right: A. V. Loog, C. L. DuBois, J. F. Busch, T. E. Battaglia, W. A. Schroeder and J. B. Hennessy



O. D. M. Guthe C. R. Moore



W. J. Shackelton C. A. Sprague

Retirements

Recent retirements with Class A pensions under the Retirement Age Rule were: O. D. M. Guthe, with 39 years of service; C. J. Hendrickson and Nicholas Flynn, 31 years; and C. A. Sprague, 28 years. C. R. Moore retired at his own request with a Class A pension after 29 years of service, and W. J. Shackelton with a Class B pension after 36 years.

William J. Shackelton

After graduation from the University of Michigan with a B.S. degree in 1909, Mr. Shackelton, Transmission Apparatus Engineer, joined the training course of the Western Electric Company at Hawthorne. He came to New York in 1910 and was assigned to the Physical Laboratory for work on development of loading coils and for pioneering work in the field of precision a-c electrical measurements.

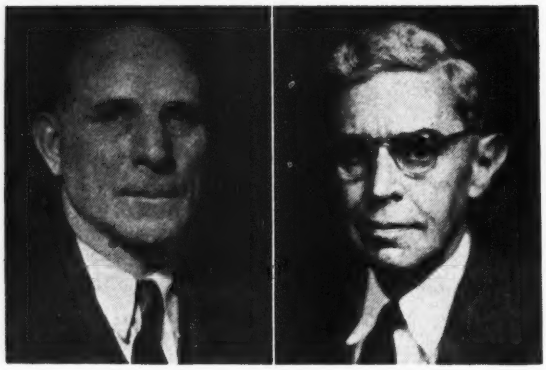
Progressively, other transmission apparatus components were added to his responsibilities, including condensers, transformers and coils. Among these were two matters to which he made many outstanding personal contributions and in which he attained a nation-wide reputation through his publications and through serving on committees of the American Society for Testing Materials and the American Standards Association. These matters dealt with general studies in the application of magnetic materials and refinements in the art of precision electrical measurements of impedance, time and frequency. His contributions in this field played an important part in the successful development of testing facilities for carrier and radio telephone systems.

In 1928 he was appointed Transmission Apparatus Engineer. During World War II he also had charge of important projects for the U. S. Navy concerning the development of magnetic devices for various applications, including the detection of submerged magnetic bodies. He was also appointed a consultant by the N.D.R.C.

Clarence A. Sprague

Mr. Sprague, after graduating from Syracuse University in 1904 with a B.S. degree, taught physics for several years in the North Carolina State College at Raleigh. He then entered the Patent Office in Washington, where for six years he examined applications in the classes of radio signaling and telephony. Meanwhile he studied law at George Washington University and received the degree of LLB. in 1916. He also holds the degree of M.P.L. for courses taken at Georgetown University.

In 1916 Mr. Sprague took a position as assistant to Cornelius D. Ehret, a patent attorney of Philadelphia, and the following year entered the Patent Department of Western Electric Company. From 1917 to 1923 he was in charge of the patent work on radio and wire carrier systems. He next supervised the work on permalloy and its applications and on submarine signaling until formation of the Laboratories' Patent Department in 1925, when he became head of its application division. Upon discontinuance of that division in 1927, he became head of the department formed to handle television and telephotography. His department was responsible also for the work on photoelectrics, photography, optics, gain and volume control, and voltage regulation.



NICHOLAS FLYNN C. J. HENDRICKSON

While handling the patent work in these different fields he occasionally contributed an invention of his own; 16 patents have been granted to him on signaling.

Charles R. Moore

Mr. Moore received the degree of B.S. in both M.E. and E.E. from Purdue in 1907 and that of E.E. from the same university in 1910. From 1907 to 1913 he was associated with Purdue first as instructor and later as Assistant Professor of Electrical Engineering and he served in the latter capacity at the University of Illinois from 1913 to 1916. He came to West Street in 1916, where he was soon placed in charge of transmitter development. During World War I, he was given supervision of a laboratory boat on Long Island Sound for the investigation of submarine-detecting devices.

Following the war, one of Mr. Moore's first undertakings was the transmitter for the handset. Major improvements were also made in transmitters of the high-quality type and as a corollary to this work he was associated with the development of two harmonic analyzers. In 1928 he was placed in charge of tool development in the Outside Plant Development Department, where he was responsible for the single-sleeve rolled joint now standard in the Bell System and the tool for making such joints. Since 1936 Mr. Moore has been in the Switching Apparatus Development Department and more recently in the Station Apparatus Department, in charge of the development of a new dial for subscribers' telephones. The 35 patents which have been issued in his name indicate his many contributions to the telephone art.

Olof D. M. Guthe

Born in Sweden, Mr. Guthe graduated from the Electrical Institute of Sweden in 1900, specializing in mechanical engineering, and received a scholarship which entitled him to study in several foreign countries. He came to this country in 1903, and three years later joined the New York and New Jersey Telephone Company as a draftsman. He soon transferred to the Western Electric Company at West Street on similar work.

In 1913 he joined the Patent Department where, until 1920, he was successively patent draftsman, chief patent draftsman and office manager. Then, for two years he handled foreign patents. Since 1923 Mr. Guthe had been engaged in patent work covering telephone systems. This included such apparatus as step-by-step, panel, coordinate and crossbar; circuits and equipment for dial systems; and station apparatus.

Charles J. Hendrickson

Mr. Hendrickson's first contact with the Bell System was during the summer of 1904, when he assembled desk stands for the Western Electric Company for three months. He then spent two years at Lehigh and two more at Harvard. Following eight years with other concerns, he joined the machine switching development group of the Western Electric Company in 1914.

In 1917 Mr. Hendrickson enlisted in the U. S. Army, and after being commissioned Second Lieutenant in the Air Service, he was at Wright Field and Honolulu. At the end of the war he returned to the machine switching group. When the Inspection Engineering Department (now the Quality Assurance Department) was formed in the Middle Twenties, he transferred to this department. Since then he had been engaged

"The Telephone Hour"

NBC, Monday Nights, 9:00 p.m.

February 11	*Marjorie Lawrence*
February 18	*Bidu Sayão*
February 25	*Maggie Teyte*
March 4	*Lily Pons*

in engineering complaint and quality survey work on central-office apparatus, including step-by-step, panel and crossbar.

Nicholas Flynn

Mr. Flynn joined the Western Electric Company in 1914 as a fireman at the time when all electric power and steam for the West Street building were generated in its own power plant. After the generation of power was discontinued in 1923, he operated the liquid air equipment and assisted in charging and maintaining storage batteries and in maintaining boiler room equipment. About 10 years ago he returned to his earlier work of firing.

During the early part of 1942 he was made a uniformed watchman and was usually stationed at the 734 Washington Street door, where he remained until his retirement.

Laboratories Awarded Certificate for AAF Training Program

Bell Telephone Laboratories has been presented with a Certificate of Service Award by the Army Air Forces Training Command "in recognition of the meritorious service rendered" that Command during World War II. The School for War Training was organized and operated to give instruction in devices and methods developed to keep the air armadas of the country flying. Although the program was set up originally at the request of the Signal Corps, the services of the School were commanded by a number of branches of both Army and Navy, as discussed in the article on page 66.

In the letter to Dr. Buckley accompanying the award, Lieut. Gen. B. K. Yount, of the Army Air Forces Training Command, stated that "your organization has made a fine contribution to the global war and the many young Americans who learned at your installation to maintain and to service the equipment of our Air Forces were among those keeping 'em flying on the Nation's widespread front line of offense. You and the men and women of your organization may be assured that this recognition typified the appreciation of this Command for your material contributions to Total Victory."

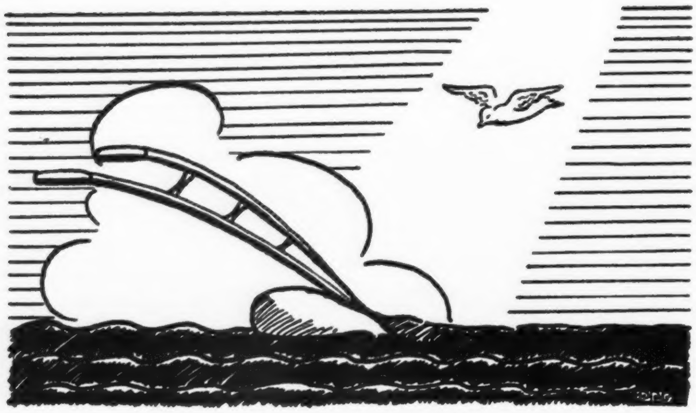
Apparatus Development Department Organization Changes

W. J. Shackelton retired with a Class B pension on January 1. F. J. Given became Transmission Apparatus Engineer in charge of the work on transmission transformers and power apparatus, in addition to the groups he previously supervised. N. Botsford, A. J. Christopher, P. S. Darnell, R. W. DeMonte and V. E. Legg now report to Mr. Given.

R. G. McCurdy assumes the duties formerly performed by Mr. Shackelton with respect to the groups on electrical measurements and magnetic studies and applications. J. G. Ferguson and A. G. Ganz report to him in that capacity.

Production of Telephones Uninterrupted by Move

Western Electric's new Archer Avenue plant in Chicago turned out its first telephone on December 17, just 17 days after company engineers received the keys to the building. On the first day of December, plant engineers moved into a part of the new plant and began building new conveyor lines. Meanwhile, at the Hawthorne plant, three miles away, production continued at full speed until Saturday night, December 15. On Sunday, while production workers were enjoying their regular day off, maintenance crews moved certain of the conveyors, furniture and tools from Hawthorne into the new location. So carefully was the new move planned that the first set produced at Archer Avenue came from the new assembly line at 7:12 a.m. Monday.



We Welcome Back

Capt. Nels C. Youngstrom was assigned to the Third Naval District as Matériel Officer, Local Defense Forces, from March 3, 1941, to February 12, 1943, when he was assigned to the 8th Amphibious Force in the North African area. For his exceptional work with underwater sound defense systems there, he received a commendation from Admiral Hewitt. He returned to the States and, as commander of a communications unit, trained 550 men at Camp Pendleton, Cal., before joining the staff of CINCPAC at Pearl Harbor for temporary duty of four months dealing with harbor defense matters. In April, 1945, he was assigned to the staff of Commander Service Force Pacific to do communications planning. On that assignment he was detailed to Okinawa as service force representative for Navy radio installations and was assigned to the staff of the Army Signal Officer at Okinawa.

Upon the request of the Signal Corps, **Col. James W. McRae,** in April, 1942, accepted a direct commission as a major and began active duty. His work for Col. Rives and Col. Downing in the Office of the Chief Signal Officer was primarily concerned with coördinating the development program of Signal Corps airborne radar and radio counter measures. In Washington, he also served on the counter measures, radar, and procurement precedence committees of the Joint and Combined Communications Board. He made a trip to England during this period in order to study radio and radar counter measures at Malvern and London. In June, 1944, he transferred to the Signal Corps Engineering Laboratory, Bradley Beach, N. J., as Chief of the Engineering Staff and part of the time served as Deputy Director of the Engineering Division.

Lt. (jg) M. P. Hughes Capt. Youngstrom

Lieut. (jg) Martin P. Hughes was commissioned at Pensacola in May, 1943, and thereafter spent thirteen months in the South Pacific with a patrol squadron. He piloted PBY's on rescue and routine anti-submarine patrol work in the New Hebrides, Fijis, and Solomons. He was later stationed at Squantum, Mass., where for thirteen months he served as station pilot, assistant operations duty officer, and station photographic officer.

Lt. Col. K. O. Thorp Col. J. W. McRae

Lieut. Col. Kermit O. Thorp was asked in 1941 by his friend, General James Doolittle, to work on aircraft procurement, and went to the Allison Division of General Motors as AAF representative for procurement of aircraft engines. Col. Thorp organized the Indianapolis Miscellaneous Procurement Office and later transferred to Consolidated Vultee Aircraft Corp., Nashville, Tenn., as Air Technical Serv-

ice Command representative for the procurement of aircraft. He subsequently became the regional representative for miscellaneous procurement. Colonel Thorp was last assigned to St. Louis as regional representative for miscellaneous procurement.

Lieut. Comdr. Raymond A. Kempf was ordered to active duty with the Office of the Chief of Naval Operations, Division of Naval Communications, in March, 1941, and much of his service was at established naval radio stations, or other shore-based communications facilities, at Washington, D. C., San Francisco, Pearl Harbor, and Guam. He spent several months at the West Street Laboratories, a year with Laboratories and A T & T personnel in

J. J. McKeon

J. J. Mosko

California, and a year with the U. S. Army Signal Corps. During that time he worked on many interesting developments in radio communications, several of which were a direct contribution of the Laboratories.

Before going to O.C.S., **Maj. Walter W. Maas** had two years' training in the AAF and was a coast patrol radio operator at San Bernardino, Cal. After receiving his commission at Ft. Monmouth, he was assigned to the Aircraft Warning Unit Training Center at Drew Field, Fla., where he was assistant executive officer for two and one-half years. He then became assistant executive officer of the Eastern Signal Corps Training Center.

John J. McKeon recently returned to the Shipping Department. He began service with the Navy in February, 1945. After his boot training at Sampson, he continued there in the Ship's Company as Assistant Chief Petty Officer, instructing new recruits. Later, he transferred to Shoemaker, Cal., where he was engaged in mess cooking until his discharge.

John J. Mosko began training in July, 1944, and went overseas with the 83rd Division on January 1, 1945. He was with the First and later the Ninth Army in the Ardennes, the Rhineland and Central Europe. He received the Combat Infantryman Badge, three battle stars, and the Purple Heart with an oak leaf cluster.

Maj. W. W. Maas

Lt. Comdr. Kempf

Major Donald E. Thomas was assigned to the office of the Chief Signal Officer following active duty at the Laboratories. He did scientific liaison work with the NDRC on radar equipment. In March, 1943, he was made officer-in-charge of the Radio Counter Measures Section of the Radar Branch and was charged with staff supervision and planning of research and development of radio and radar counter measures equipment. A year later he proceeded to the ETO at the request of the AAF to observe the operational effectiveness of RCM equipment and for consultation on plans for use of counter measures in the forthcoming invasion of the European continent. He transferred from the Signal Corps to the Air Corps in October, 1944, and was assigned to Headquarters, Air Technical Service Command, Wright Field, Dayton, Ohio, as Assistant Chief of the Plans Section in the Air Communications Office. Major Thomas was charged with technical planning of all types of radio and radar equipment for AAF use. He later transferred to Headquarters, AAF, in Washington, D. C., and was assigned to the office of the Assistant Chief of Air Staff-4 Engineering Branch.

Major D. E. Thomas

Lt. Col. Holmlin

R. W. SEARCH

L. M. NIELSEN

SPENCER FOSTER

W. J. PERRY

G. E. HELMKE

MA

Lieut. Col. Harry W. Holmlin was ordered to the Engineer School at Fort Belvoir, Va., in December, 1940, as a first lieutenant. After successive engineering assignments and promotions, he was given command of the 69th Infantry Division's Engineering Battalion in June, 1944, at Camp Shelby, Miss. In November the division embarked for the ETO. For four months until May 8, the 69th Division was in continuous combat in Belgium and Germany with Col. Holmlin as Division Engineer and Combat Battalion Commander.

For meritorious service in directing Engineer support for breaching the Division's gap in the Siegfried Line, for several river crossings under enemy fire, and assisting the advance of the infantry over 440 miles ending with the 69th Division capturing Leipzig and later becoming the first American troops to meet the Russian Army on the Elbe River, Col. Holmlin received the Bronze Star Medal and two battle participation stars. After four months of occupational duty in Germany, he was inactivated along with his division.

T/Sgt. Robert W. Search joined the AAF in May, 1943, and went to radio school at Ft. Myers, Fla., and gunnery school at MacDill Field, Fla. He went overseas in October, 1944, and was a radio operator on a B-17 during thirty-five missions, for which he received the Air Medal and six oak leaf clusters. Upon returning to the United States in April, 1945, he instructed radio theory at Scott Field, Ill.

Spencer Foster was a Storekeeper 1/c during his naval duty which took him to the Aleutians for five months aboard a sub-chaser and to Saipan, Okinawa, Iwo Jima, and Japan for two years of Pacific service.

William J. Perry was attached to the Military Police at Camp Stoneham, Calif., for two months before attending New York University through the ASTP to study basic engineering. With the 104th Infantry Division he went overseas and fought through France, Belgium, Holland, and Germany as a demolition man. He remained on occupation duty in Halle, Germany, before returning to the States to be discharged.

Leonard M. Nielsen enlisted in the Signal Corps in November, 1942, and received training in central-office installation and maintenance at Camp Edison and Fort Monmouth, N. J. He spent twenty-two months in Greenland at Bluie West One air base doing this work and was later stationed at the Post Signal Office, Camp Dix, N. J., maintaining and repairing telephones before his discharge.

George E. Helmke, RM 1/c, went to radio school at Newport, R. I., and radio direction finder school at Portland, Maine. He was assigned as radio operator to the destroyer U.S.S. *Doran* which aided in the invasion of Sicily and later to the U.S.S. *Nelson* which was in the invasion of France. He traveled about 100,000 miles before leaving his ship in Korea.

Chief Radarman Donald L. Viemeister studied radio operation and theory at Noroton, Conn., when he enlisted in the Navy in November, 1940. He was assigned to the U.S.S. *Idaho* as radio operator for the first two years and then as chief radarman until his discharge. He went with the *Idaho* on neutrality patrol to Iceland in the summer of 1941 and thereafter through the campaigns in the Gilbert, Marshall, Marianas, Caroline, and Philippine Islands, Iwo Jima, Okinawa, and the initial landing at Tokyo.

Frederick W. Schwartz, FC 2/c, said he saw "plenty of combat" aboard the U.S.S. *Renshaw,* on which he operated a main battery director and computer. His ship was in the Solomons, Marianas, and Philippines.

D. L. VIEMEISTER

F. W. SCHWARTZ

FLORENCE A. LUTGEN

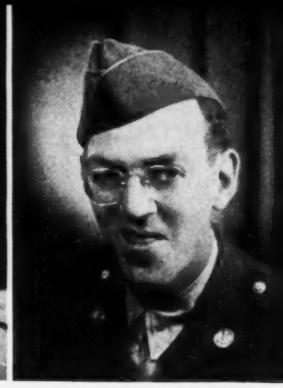
J. J. MCCALLION

R. S. TROELLER

Maj. F. B. Blake

F. J. Osolinik

Capt. L. T. Miller



H. J. Stewart

Capt. John Marrero

Florence A. Lutgen enlisted in the Waves in December, 1942, and attended Aerographer's School at Lakehurst, N. J., for three months. She was assigned to the lighter-than-air naval air station at Glynco, Ga., where she briefed crews on weather conditions in operating areas and made forecasts.

John J. McCallion has returned to the Plant Department at Murray Hill. While with the Army he served in the Mediterranean theater of operations for a year and a half and in the European theater for one year. He holds the European-African-Middle Eastern Service Ribbon with two battle stars—one for the Rome-Arno Campaign and one for the Battle of the Rhineland.

Raymond S. Troeller, 130th Inf. Div., 117th Reg., was almost the sole survivor of his company after they had made the initial attack on the Siegfried Line. Pvt. Troeller was hit with mortar fire while operating a flame thrower against pillboxes. He was evacuated to Paris and England and then to Columbus, Ohio, spending thirteen months altogether in hospitals before his discharge.

Major Foster B. Blake received a direct commission in September, 1942, and was assigned to the Technical Training Command District Headquarters at Sedge Field, N. C., as assistant signal officer for four months. Thereafter, he worked at the Signal Office of the AAF basic training center at Greensboro, N. C., until his release. This location is unique in that it serves a triple function as overseas replacement depot, redistribution center, and separation center.

Harry J. Stewart left the States from Seattle for Hawaii. Originally with the Signal Corps, he was there transferred to the Tank Corps as a radio operator. He was in operations in Peleliu, New Caledonia and Leyte.

T/Sgt. Frank J. Osolinik was a statistician in the classification office at Fort Monmouth for eleven months where he also studied communications. Following additional training, he was stationed at Robins Field, Macon, Ga., from which base, on detached service, he went to California, Nebraska, Texas, Indiana, and Kentucky to install communications for aircraft warning systems.

Capt. Louis T. Miller enlisted in the AAF in April, 1941, and was commissioned at Maxwell Field, Ala. He stayed on as a single-engine pilot instructor, teaching there and at Dothan, Ala., and surrounding territory for about three years. Capt. Miller also completed B-24 training at Smyrna, Tenn., and B-29 training at Maxwell Field.

Capt. John Marrero received his commission after OCS at Camp Davis, N. C. He joined an anti-aircraft battalion and went overseas to North Africa and Italy. His battalion was converted into a 4.2 chemical mortar battalion with the Fifth Army. Capt. Marrero served in the Rome-Arno, Appenine, and Po Valley Campaigns during which he was awarded the Bronze Star and promoted from a platoon to a company commander.

S/Sgt. Thomas E. Jew attended radio and gunnery schools and went overseas in May, 1944. He was a radio operator and gunner on B-17's with the 15th AAF in Foggia, Italy, and later he was engaged in aircraft radio maintenance. He was awarded the Air Medal and has eight battle stars on his ETO ribbon.

Sgt. William B. Adam was assigned to maintenance of aircraft radios with the 5th AAF in Australia and was later a radio operator on C-47's and B-25's traveling to Nadzab, Finschhafen, Cape Gloucester, Hollandia, and Owi Island. At Mindoro Island, as a communications technician, he supervised the work of

T. E. Jew

W. B. Adam

J. D. Ontka

J. P. Craven

E. E. Francois

JOHN J. TURLEY

thirty other men on aircraft radio maintenance. He also visited Ie Shima, Leyte, and Okinawa, and was awarded the Air Medal, Philippine Liberation ribbon with one star, seven battle stars, and the Victory Medal.

James P. Craven, S 1/c, served aboard the U.S.S. *Monitor* (LSV-5) at Pearl Harbor, the Philippines, New Guinea, and Okinawa. He returned to Pearl Harbor and the States after the Okinawa invasion, only to leave again as a gunner on an LCVP. He was in Saipan when the war terminated and traveled north to meet the Third Fleet off Tokyo where they took sailors to man the Yokosuka naval base. He stayed in the Tokyo area for about a month while released American POW's were taken aboard. These were carried to Manila. On their return trip to the States, he stopped at Manus to bring back discharged sailors.

Cpl. Eugene E. Francois enlisted as an aviation cadet and received training at Greensboro, N. C., Blytheville, Ark., Columbia, Ohio, and Albany, Ga., before the program closed and terminated his flying. Thereafter he served as a classification specialist at Columbus, Ohio.

After **Joseph D. Ontka's** amphibious training, he was assigned to the APA U.S.S. *Berrien* which carried fifteen LCVP's. He was an LCVP coxswain during the Okinawa invasion, carrying ammunition, supplies, and wounded. Other ports of call made during his sea duty were Saipan, Tulagi, New Caledonia, and Guam.

John J. Turley attended radio operator's school and spent one year in England operating radar sets with the 555th Signal Air Warning Detachment. He also participated in the First Army's push through France, Belgium, Luxembourg, Holland, Germany, and Czechoslovakia. After V-E Day he was on occupational duty near Munich.

Cpl. Charles T. Bolger was a radio and radar operator on an outpost 13½ miles from New Caledonia for twenty-one months. He was then assigned to a photographic school at Fort Belvoir, Va., and then to Louisiana to work on the tri-state flood control radio project.

Robert W. M. Blaschke shipped to northern Ireland and England and was in the invasion of Normandy and southern France aboard a mine sweeper. He was later assigned to a repair unit at a mine sweeper and repair base in Norfolk, Va.

In December, 1942, **Sigmund Fronczak, EM 1/c,** went to Londonderry, Ireland, with a ship repair unit and stayed there ten months. He was then assigned to the destroyer U.S.S. *Ordronaux,* which provided shore bombardment for the invasion of southern France and the push from Anzio to Rome. During his last months of service he was stationed at the Brooklyn Navy Yard working on a diesel-electric tug.

A B-24 pilot, **Lieut. William T. Reck** twice flew bombers to Scotland after his commissioning. He was stationed at Mitchel Field and Selman Field, La., where he flew navigation students and expected to go on to B-29 school but was released after V-J Day. Mr. Reck intends to study mechanical engineering at Penn State this year.

Eugene H. Jockel installed IFF sets in P-47's while stationed with the 9th AAF in Chilgolton, England. His outfit later transferred to Normandy, Belgium, and Germany. After V-E Day he was assigned with the occupation forces in Nuremberg for several additional months.

In 1941 **Anthony J. Osinski** joined the Army and received training as a radio and radar operating technician which was his duty during two years in the Aleutians. He returned to the States in 1944 and instructed radar flying in B-26's at Ontario, Calif., before receiving his discharge at McClellan Field, Calif.

Capt. Robert L. Tambling spent ten weeks working on radio teletype at the Plant Engineering Agency in Philadelphia following the beginning of his active duty in February, 1943, and was then transferred to the Radar Laboratory at Wright Field, Dayton, Ohio. As Design and Development Officer, he dealt with components of radar sets and in May, 1945, was transferred to the Radio and Radar Subdivision of the Air Technical Service Command as a member of the Technical Staff.

ROB

C. T. BOLGER

R. W. M. BLASCHKE

SIGMUND FRONCZAK

E. H. JOCKEL

LT. W. T. RECK

ROBERT MONAHAN LT. R. C. NANCE P. R. BROCKETT A. A. LUCIANO J. F. MCGUIRE

Henry J. Boyle has been reinstated in his former position in the tabulating group, which he left in October, 1942, to train at Fort McClellan, Ala., and Fort Benning, Ga. Attached to the field artillery of the First Army, he participated in the fight through France, Belgium, Germany and Czechoslovakia.

Sgt. Francis E. Tucker has been reinstated from his military leave of absence following his Army career in radio work since July, 1942. His basic training was at Keesler Field, Miss., from which he was sent to the Air Forces Radio School at Sioux Falls, S. D., for an eighteen-week course. He stayed on there as an instructor of radio theory until May, 1945, when he was sent to Truax Field, Madison, Wis., to instruct a course in radio repair until his discharge in November, 1945.

T/5 Walter Schleicher began military service in September, 1943. After training at Camp Crowder, Mo., he was assigned to the South Post, Ft. Myer, Va., and worked in the Pentagon Building installing and maintaining multi-channel radio-telegraph for intercontinental radio and telephone communications.

Charles H. Matthews enlisted in January, 1943, took boot training at Norfolk, Va., went to the replacement center at Williamsburg, Va., and took advanced training at Davisville, R. I., and Pt. Hueneme, Calif. As a Storekeeper 1/c, he was stationed on Attu in the Aleutians with the Seabees. After an interval at Camp Parks, Calif., he exchanged the cold climate of Alaska for the tropical heat of Manus in the Admiralty Islands until the middle of September, 1945.

Turner Field, Ga., was **Robert Monahan's** base for three years. For one year he served with the Military Police, and thereafter was first sergeant in a flying training squadron. He went overseas to Algiers and Dakar in 1944 with the Air Transport Command.

The National Guard brought **Lieut. Robert C. Nance** into active duty in January, 1941, and he received his commission at Ft. Monmouth after OCS. Lieut. Nance served in Attu, Kiska, Hawaii, the Marshall Islands, Leyte, New Guinea, Luzon, and Okinawa. He was awarded the Bronze Star for meritorious service.

Perry R. Brockett enlisted in the Coast Guard and was stationed in southern New Jersey on beach patrol for seven months. He then went to school in New York and was later assigned to the U.S.S. *Brisk,* which ran convoy duty between New York and Cuba.

A. A. Luciano has returned to Whippany after twenty-six months' service with the U. S. Navy Seabees. He spent one year on overseas duty in the Pacific and was at Guam for six months. During the Okinawa campaign he served on an LST.

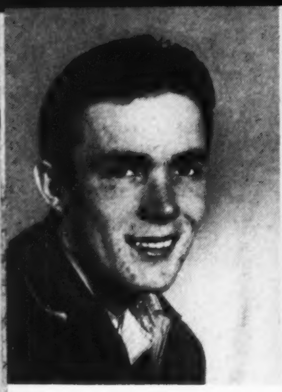
John F. McGuire had ten months' basic infantry training at Camp McCain, Miss., participated in the Tennessee maneuvers, was assigned to Ft. Jackson, S. C., and went overseas in April, 1944, to North Africa. With the Fifth Army, he fought at Rome and was twelve miles from Bologna when he was hit by a bullet and hospitalized.

Ensign Warren M. Prall enlisted in the naval aviation cadet program in January, 1943, and received his commission at Pensacola in September, 1944. He took operational training in dive bombers at Deland, Fla., and joined a scouting squadron at Banana River, Fla., on anti-submarine patrol duty.

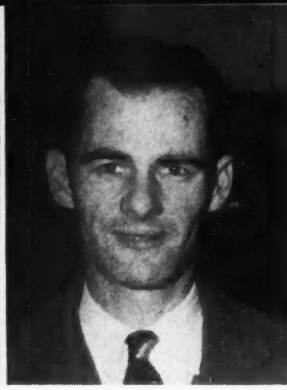
Edward P. Hullah was assigned to the 2nd AAF Headquarters in Spokane, Wash., which was later moved to Colorado Springs. He did clerical work there, and later with the Contract Order Branch of the 6th AAF Base Unit. After schooling in Dayton, Ohio, he was transferred to the New York headquarters.

From Camp Edwards, Mass., **John J. Lordan** went to North Africa with an antiaircraft artillery unit, to Naples and Anzio with the Fifth Army, to Civitivecchia with the Seventh Army, and to southern France on D-Day. He continued up through France, across the Rhine to Germany, and stopped at Augsburg. After V-E Day he was assigned to guarding S.S. prisoners. He received the Bronze Star for meritorious service.

John J. Lordan with his sister, Helen V. Lordan, who also works in the Laboratories



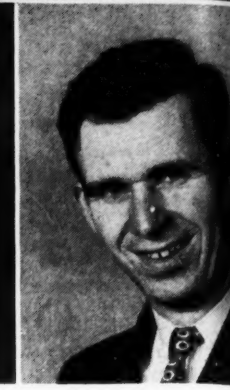
J. R. Merchant



J. P. Fraser

D. W. Jones

R. G. Dolbear



H. G. Hohner

J. R. Merchant has returned to the Laboratories following his discharge from the Army Air Forces where he served as an Aviation Cadet since November, 1943. Mr. Merchant attended pre-flight and flight engineering schools at Maxwell Field, Alabama, and at Amarillo, Texas. About four and a half months of his service were spent on an MP assignment.

S/Sgt. John P. Fraser joined the Army in April, 1941, and took basic training at Keesler Field, Miss. He was assigned to Turner Field, Albany, Ga., for air crew training and remained there until discharged, although the air crew training program closed. In the meantime, Sergeant Fraser was non-commissioned officer in charge of map and airways base operation which necessitated his checking arrivals and departures, traveling conditions, fuel supplies, air routes, and making flights as a crew member.

Edward B. Gempler was assigned to Tompkinsville, S. I., after his enlistment in the Navy in October, 1942, and then to the Radio Matériel School at the Naval Research Laboratory, where he studied maintenance of radio, radar, and underwater sound equipment. He served aboard the DE701 as leading radio technician until his recent discharge, after spending two and one-half months in the Atlantic and eighteen months in the Pacific. Their operations took him to Bougainville, Tulagi, Guadalcanal, Hollandia, Saipan, Guam, Tinian, Leyte, Okinawa, Palau, the Admiralty Islands, Truk Island, the New Hebrides, and Rota Island. His ship accepted the Japanese surrender at Truk and Rota Islands.

E. B. Gempler

C. E. Klein

D. W. Jones has returned to Whippany after seventeen months of Army service. He was with the 80th Division of Patton's Third Army and was wounded in the Ardennes Campaign. Following his return to the Woodrow Wilson Hospital at Staunton, Va., he was discharged. Mr. Jones holds the European-African-Middle Eastern Campaign Ribbon with one battle star, the Combat Infantryman Badge, the Good Conduct Medal and the Purple Heart.

R. G. Dolbear has returned to Whippany from twenty-two months' overseas Army service. He was in the Transportation Corps and was stationed at various supply depots in England. Mr. Dolbear commented that although he did not see any front-line fighting, he experienced several air raids which brought the war too close for comfort. He returned to the States on the new aircraft carrier *Lake Champlain.*

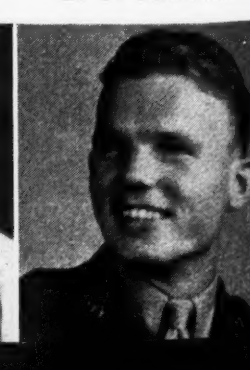
T/4 Henry G. Hohner, formerly a Whippany man, has returned to work after military service from April 20, 1943, to November 6, 1945. During this time he spent sixteen months in the Publications Agency at Fort Monmouth, N. J., as a

Robert Cordell

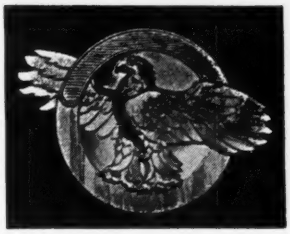
E. J. Buckley

J. W. Wolek

J. W. Cunningham



B. P. Maksym



The Laboratories has employed 540 veterans of World War II

draftsman. He had four months of field training at Allaire, N. J., and returned to the Service Cadre at Fort Monmouth expecting to go overseas, but instead received his discharge.

Charles E. Klein began active duty in March, 1943, at Camp Barkeley, Texas, where he stayed several months before going to John Tarleton Agricultural College in the ASTP. He went overseas in 1944 and was a first scout with the 9th Division in France, Belgium, and the Hurtgen Forest, where he was hospitalized.

Robert Cordell of the Financial Department worked in the Army's Financial Department for the three years of his military service. He was successively stationed at Army air bases in Talara, Peru, Guatemala City, Galapagos Island off Ecuador, the Easter Islands off Chile, and San Jose, Costa Rica, with the 6th AAF.

Following his enlistment in August, 1943, **Edward J. Buckley** trained at Camp Perry, Va., and Pt. Hueneme, Cal., before going overseas with the Seabees. He had shore duty in the New Hebrides and Solomon Islands maintaining radio communications. In July, 1945, he returned to attend radio school in Dearborn, Mich., which closed after V-J Day.

Joseph W. Wolek was ship's cook at Tompkinsville, S. I., for a year and a half. He had four months' sea duty aboard the U.S.S. *Chaffinch*, a mine sweeper, before the ship was decommissioned in South Carolina.

James W. Cunningham began service with the 35th Division of Combat Engineers at San Luis Obispo, Cal., and Camp Ruckner, Ala., and then entered the ASTP, attending Auburn College, Alfred University, and Manhattan College. Sgt. Cunningham served with the 15th AAF in San Severo, Italy, where he installed, maintained, and repaired cameras in P-38's for eleven months. He received the Distinguished Unit Citation with cluster and four battle stars.

T/Sgt. Benjamin P. Maksym attended radio and gunnery schools in the States, and in April, 1944, joined the 8th AAF overseas as a radio operator and gunner on B-17's and B-24's. He completed thirty-four missions, for which he received the Air Medal with three clusters, the DFC, and four battle stars.

Maxwell M. Bower recently learned that he had received a retroactive promotion to Lieutenant Colonel.

Other Military News Notes

Dietrich K. Wagner is at Fort MacArthur, Calif., processing men for discharge.

Anthony L. Ferrara is located at the Yokosuka Naval Base in Japan

Lieut. Robert S. Williams reports that his wife has joined him in Trinidad and that they met Frank and Helen Hanley while they were at Miami Beach.

Frank A. Koditek visited W. A. Boyd recently while home from the Illinois Institute of Technology in Chicago where he is studying electrical engineering in the V-12 program.

Lieut. (jg) Harold M. Baily, a radio technician, has made an around-the-world trip with the Merchant Marine.

Thomas E. Baily, A/S, was another holiday visitor at West Street before returning to the ROTC program at Yale University, where he is studying mechanical engineering.

Lieut. James Hoagland is teaching radar school at Guam in addition to being assistant mess hall officer.

Lieut. Comdr. Charles E. Clutts, with the Bureau of Ships in Washington, continues to find his experience there both "interesting" and "productive."

George J. McArdle is "sweating it out" over in Vienna with the occupation forces awaiting discharge.

Leaves of Absence

As of December 31, there had been 1,021 military leaves of absence granted to members of the Laboratories. Of these, 324 have been completed. The 697 active leaves were divided as follows:

Army 363 Navy 246 Marines 24

Women's Services 64

There were also 18 members on merchant marine leaves and 4 members on personal leaves for war work.

Recent Leaves

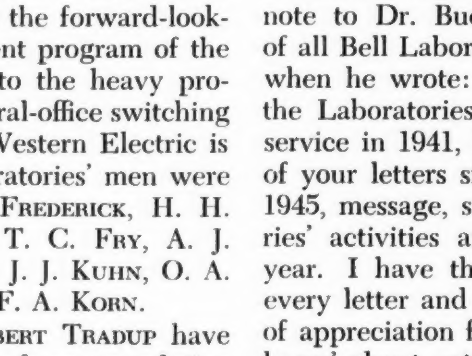
United States Army	*United States Navy*
William J. Chapp	Malcolm D. MacCoun
William Ditty	

The Choral Group on the stage of the Murray Hill auditorium just after they had presented the annual Christmas concert. Daniel Kautzman, director of music at Summit High School, is director, and Robert N. Larson, of the Personnel Department, president

News and Pictures of the Month

M. J. Kelly, A. B. Clark and D. A. Quarles, accompanied by members of the Laboratories, conferred with the Hawthorne manufacturing people from December 11 to 13 in connection with the forward-looking telephone development program of the Laboratories as related to the heavy production schedule of central-office switching equipment with which Western Electric is now faced. Other Laboratories' men were W. H. Martin, H. A. Frederick, H. H. Lowry, F. J. Scudder, T. C. Fry, A. J. Busch, H. O. Siegmund, J. J. Kuhn, O. A. Friend, E. J. Kane and F. A. Korn.

A. B. Clark and Albert Tradup have each received a letter of commendation from Henry L. Stimson, Secretary of War, for outstanding assistance rendered while serving as members of his office during the war. "The work done by you," the letter states, "resulted in a substantial improvement of point-to-point fixed and mobile tactical communications in the European and Mediterranean theaters of operation, as well as in certain changes in overall military communications practices and techniques, which directly influenced our winning of an early victory over our enemies . . ."



W. H. Doherty spoke on *Radar* at the luncheon meeting of the Morristown Rotary Club on December 12 and on the following day repeated the talk for members of the Morristown Kiwanis Club.

Lieut. Col. A. G. Kobylarz, in a recent note to Dr. Buckley, voiced the feelings of all Bell Laboratories members in service when he wrote: "As a former member of the Laboratories who took leave to enter service in 1941, I have received every one of your letters similar to the December 7, 1945, message, summarizing the Laboratories' activities and current status for the year. I have thoroughly enjoyed reading every letter and my reaction has been one of appreciation for your keeping us 'in the know' about activities in New York. . . ."

Donald Voorhees, conductor of the Bell Telephone Orchestra, is being featured in a new movie of *The Telephone Hour.* The celluloid version of the popular Monday night radio program shows what takes place when Mr. Voorhees and the Bell Telephone Orchestra go on the air over the NBC network. Dr. Josef Hofmann, world-famous pianist, is the guest artist starred in the new movie.

Under the auspices of Bell Laboratories Club, a class in photography is being given by J. H. Waddell on Monday evenings at West Street. Beginning January 14, the course is scheduled to run for sixteen weeks.

J. H. GRAY visited Richmond, Va., to study underground cable problems.

A. B. REYNOLDS, accompanied by F. W. Berry of Western Electric and A. W. HAYES and J. F. CHANEY of the Laboratories, visited the Cleveland, Detroit and Chicago Distributing Houses on a survey of recovered and repaired coin collectors.

R. W. KING addressed the Philadelphia Chapter of the Cornell Society of Engineers on December 13 at a dinner meeting at the University Club in Philadelphia. Dr. King spoke on the subject *Pending Legislation Affecting Science and Engineering—in Particular the Kilgore and Magnuson Bills.*

HARVEY FLETCHER was at Washington University, St. Louis, on November 30 and December 1 to attend meetings of the American Physical Society, of which he is president.

B. S. BIGGS, in Hawthorne during November, discussed reconversion problems encountered with rubber.

J. G. KREER's name was omitted from the I.R.E. roster of Laboratories' committee members published in the December RECORD. Mr. Kreer has been a member of the *Papers Committee* of the Institute for the past four years.

S. J. MCDERMOTT and F. J. GIVEN, with L. F. Hescock of Western Electric Company, visited the Watson Laboratories at Eatontown, N. J., to discuss developments for Air Force electronic equipment.

R. H. COLLEY, G. Q. LUMSDEN and R. C. EGGLESTON went to Spartanburg, S. C., to witness pole breaking tests, in coöperation with the Taylor-Colquitt Company, on poles treated by a new vapor-drying process.

W. E. MOUGEY, J. G. BREARLEY, A. G. HALL and J. W. KENNARD, accompanied by S. A. Haviland of the A T & T, and H. G. Johnstone of Western Electric, visited the Poquoson area of The Chesapeake and Potomac Telephone Company to check the performance of buried exchange area cable protected with vulcanized rubber or thermoplastic compound.

D. R. BROBST, N. BOTSFORD, K. G. COMPTON and W. J. CLARKE visited Hawthorne to discuss enameled wire problems.

DURING the month of November the United States Patent Office issued patents on applications previously filed by the following members of the Laboratories:

T. L. Dowey (2)	E. J. Murphy
C. J. Frosch	G. L. Pearson
C. S. Fuller	V. L. Ronci
J. J. Kleimack	E. M. Staples
W. A. Malthaner	E. R. Taylor
H. J. Michael	

J. F. POLHEMUS, in Baltimore on December 20, observed the installation of main repeater station equipment for the New York-Washington coaxial cable.

A. B. HAINES visited the Western Electric Company plant at Haverhill in connection with the manufacturing of power apparatus for the telephone plant.

N. BOTSFORD was at Haverhill to discuss transformer problems.

February Service Anniversaries of Members of the Laboratories

40 *years*

W. S. Boerckel
L. J. Bowne

35 *years*

James Barton
W. M. Beaumont

30 *years*

H. F. Beck
K. G. Coutlee
W. E. Harnack
F. H. Hibbard
A. W. Kishpaugh
W. J. Leveridge

25 *years*

L. B. Cooke
J. R. Fisher
W. E. Kahl
Harold Kuhn
Walter Kuhn
Herbert Maude
I. A. McCorkendale
O. L. Michal
G. F. Sohnle

20 *years*

Michael Conlon
S. C. Del Vecchio
M. F. Fitzpatrick
J. C. Hoffmann
H. K. Krist
G. J. Langzettel
G. W. Meszaros
Joseph Michal
E. T. Mottram
J. E. Nielsen
A. G. Olson
Helen Racz
P. A. Reiling
R. C. Vreeland

15 *years*

Ralph Coviello
A. E. Eberenz
James Godwin
John Griffin
B. J. Kelly
P. V. Layden
L. W. Morrison, Jr.
J. T. Motter
C. W. Petersen
H. F. Winter

10 *years*

W. S. Eno
Ernest Habit
K. H. Lloyd
J. V. Meats
Mary Upton

Anne Bookless, whose picture heads this group of Laboratories' women, is a mathematical assistant in the Transmission Networks group where she makes computations for network designs.

Next is Annette Geyer, a member of the General Accounting Department, located at Eighteenth Street, where she performs work in connection with the auditing of Laboratories' disbursements. Her hobby is gardening and just now she has ten gardenia plants blossoming at home.

Smiling as the photographer caught her on the telephone is Rita Thoubboron of the Research Staff Department. Miss Thoubboron is responsible for receiving and checking time cards for the Research Department and for maintaining an abstract file of all technical memoranda which are written by members of that department.

In the upper right-hand corner is Lynn Nosworthy of the project expediting group. Just now she is assigned to the microwave relay project, where she is engaged in making analyses of drawings and in procuring and expediting materials needed for the project.

Alice Le Mehaute, engineering assistant in the Switching Development Department, checks a folder in the 7B Files where she is responsible for all circuit records.

In the lower right-hand corner of these pages Nadia Edmands assembles a network for use on a television project. Graduate of New Paltz Teachers College, Miss Edmands does work which entails dexterity, attention to detail and a clear understanding of blueprints from which she works.

Checking by telephone with one of the outside contractors to whom she issues building passes is Winifred Danwitz. Besides this work she also supervises a group

of women engaged in building operation and maintenance.

Gloria Iannone is shown referring to records of tracings which are kept in the vaults of the Equipment Development Department Files in 9A.

Evelyn Christian checks a stock card before recording amounts on the electrical bookkeeping machine which she operates in the stock control group at Fourteenth Street. A recent bride, she corresponds daily with her husband who is with the Navy and is stationed near Samar Island in the South Pacific.

Clockwise from the top, the girls on these pages are Anne Bookless, Annette Geyer, Rita Thoubboron, Lynn Nosworthy, Alice Le Mehaute, Nadia Edmands, Winifred Danwitz, Gloria Iannone and Evelyn Christian

Assembling the new microwave tube 6AK5 is SUSIE TERRACCINO of the Electronics Apparatus Development Department in Building T. The work comes easy to her now, but behind her precision and skill are years of experience dating back to 1924 when she joined the Laboratories Tube Shop at 395 Hudson Street. At that time she had just been graduated from Manhattan Trade School where she had acquired considerable dexterity in arts and crafts. Since then, except for a period after her marriage when she remained home, Mrs. Terraccino has been engaged for the most part in experimental tube construction.

Early in the war Mrs. Terraccino's experience and ability to get along with the girls with whom she worked earned her the position of "lead girl," and in this capacity she has instructed many war workers in the assembly of various types of tubes used in conjunction with radar.

Urgently needed for experimental purposes or as models for pre-production equipment, the tubes were made by day and night, and in helping to produce them, Mrs. Terraccino saw very little of her family. They consist of her mother, who keeps house for her in the Bay Ridge section of Brooklyn, and her daughter, Theresa, a junior at Bay Ridge High School.

SUSIE TERRACCINO

* * * * *

AT THE MAIN laboratory at Holmdel, HELEN CONKLIN does secretarial and stenographic work for twelve engineers. Mrs. Conklin also operates a small switchboard, maintains the reference library and keeps the correspondence and case files for men in that location. Prior to joining the Laboratories in January, 1943, she was employed at a secretarial position at Fort Monmouth for two years; and for thirteen years previous to that time Mrs. Conklin had been secretary to the principal of the high school at Red Bank, N. J.

Mrs. Conklin was born in Red Bank and still resides in the vicinity. Both she and her husband spend a great deal of their spare time boating on the Shrewsbury River—they enjoy the sailing in summer and the ice-boating in winter.

* * * * *

PEACETIME brings back the yearning for travel to ELLEN FLAD, whose cruises, since she joined the D & R in 1926, have taken her to Europe three times, to all the islands of the West Indies, Mexico, Panama, South America, and to Hawaii by way of California. With the first rumblings of war in Europe she decided against overseas traveling and instead visited New England, Canada, the national parks and the Western states; of late, due to travel restrictions, she has had to be content with vacations in the Poconos.

M. HELEN CONKLIN

ELLEN FLAD

Miss Flad is now secretary to ALBERT TRADUP, Switching Engineer and Director of Bell

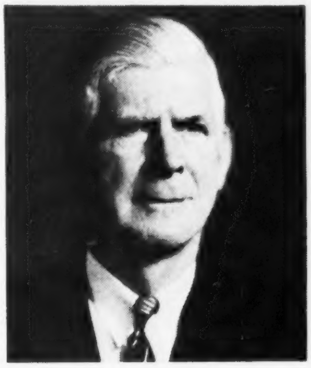
Florence Cruger | Barbara Cruger

Telephone Laboratories Training School. Writing and music are her hobbies; she has written a considerable amount of verse, accounts of her trips and short stories—as yet unpublished; she has studied piano and voice and is a member of the Bell Chorus of New York and a soloist in her church choir. She is also treasurer of the Ridgewood Methodist Church on Long Island where she lives.

The Cruger Family

Well represented in the Bell System, the Cruger family of three brothers and their sister will have accumulated 123 years of service in 1946. Meanwhile a second generation of the family have joined the group, Barbara of the Development Shops at the Laboratories and Florence of the Treasury Department at A T & T; they are daughters of John C. Cruger, a survey engineer at the W. E. Brooklyn Distributing House.

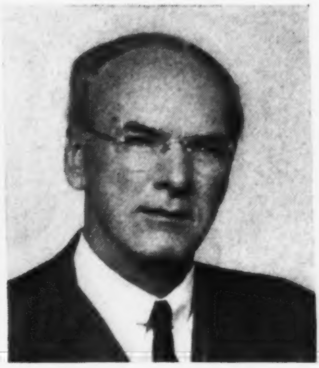
123 Years of Service



Thomas C. Cruger
BTL, Graybar-Varick
36 *years*

Elizabeth Cruger
A T & T, 195 *Broadway*
20 *years*

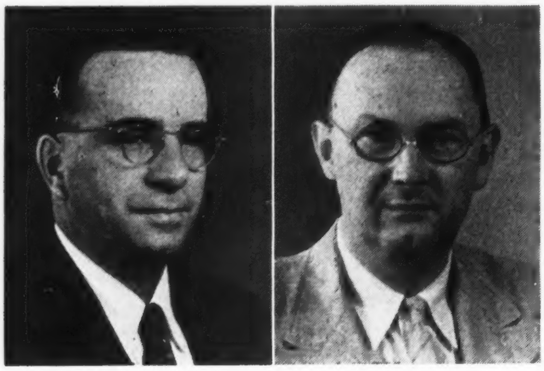
John C. Cruger
W. E. Co., Brooklyn
34 *years*



William E. Cruger
N. Y. Tel., Brooklyn
33 *years*

A. M. Curtis, 1890-1945

Austen M. Curtis of the Transmission Research Department died suddenly on December 23. A pioneering student of radio transmission since his school days, Mr. Curtis developed many ingenious arrangements of electrical circuits and mechanical devices. It was he who was listening at the radio receiver in the Eiffel Tower at Paris when spoken words were first transmitted across the Atlantic Ocean in 1915. A member of the Army Signal Corps in World War I, he advanced to the rank of captain in the Division of Research and Inspection in France. During World War II, he made a number of important contributions to secret scientific projects undertaken by the Laboratories for the Government.



G. O. Smith   A. M. Curtis

In 1907 Mr. Curtis left Heffley Institute to ship as a wireless operator for the United Wireless Company. Three years later he became chief operator and installer for the radio systems of a Brazilian shipping company, and then, in 1912, had charge of radio operations on an exploring expedition up the Amazon River for the Brazilian Department of Agriculture. Because of this experience he was called to Washington for consultation when the late President Theodore Roosevelt was planning his expedition to the River of Doubt.

Mr. Curtis joined the Engineering Department of the Western Electric Company in 1913, engaging first in studies of telephone instruments and then in the radio research that took him to Paris for the transatlantic tests of 1915. After his service in World War I, he returned to West Street to develop terminal apparatus for high-speed telegraph communication over permalloy-loaded submarine cables. In this work the provision of suitable recording oscillographs was of the greatest importance and he made many contributions to their development. One result of this work was the rapid-record oscillograph, an indispensable tool in numerous lines of circuit work. Later, he was responsible for the development of voice-operated devices such as new types of echo suppressors, vogads, volume limiters, compandors and similar devices. He also carried on his work on oscillographs and, more recently, in addition to his work in World War II, engaged in fundamental studies of circuit reactions on contact phenomena, particularly of transients occurring at the contacts.

Mr. Curtis was a charter member of the I.R.E., which was organized in 1913.

G. O. Smith, 1894-1945

George O. Smith of the Chemical Laboratories died suddenly on December 25, 1945. Mr. Smith came to West Street immediately after he was graduated by the University of Vermont in 1917 with a degree of B.S. in Chemistry. During World War I he was engaged in the development of air-damped transmitters and sensitive devices for the detection of aircraft and submarines. Since then he had been successively concerned with fundamental investigations on carbon to develop higher sensitivity in transmitters; on the behavior of metals and alloys for relay contacts; on materials for filaments; on alloys for lead cable sheaths; and on various types of materials for oilless bearings.

For the 16 years prior to World War II, Mr. Smith, in the metallurgical group of the Chemical Laboratories at West Street and later at Murray Hill, was associated with the development of copper-oxide varistors now used so extensively as circuit elements. During the war he was engaged in confidential war projects in the Labora-

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tories. The nine patents issued in his name cover phases of each undertaking with which he has been concerned, although the majority of them refer to varistors.

Mr. Smith was active in teaching First Aid under the auspices of the American Red Cross both in the Laboratories and in the Oranges and Maplewood Chapter of the Red Cross, and served in Civilian Defense First Aid activities at Murray Hill during the war period. He was a member of the Frank B. Jewett Chapter of the Telephone Pioneers.

"8:45 *to* 5:15"

Reinhold Petersen, 1875-1945

REINHOLD PETERSEN, who retired in 1930 after thirty-two years of service, died on December 16, 1945. Before his retirement, Mr. Petersen was a member of the Technical Staff of the Equipment Development Department.

News Notes

M. WHITEHEAD, at P. R. Mallory & Company, Indianapolis, discussed general problems relating to electrolytic capacitors.

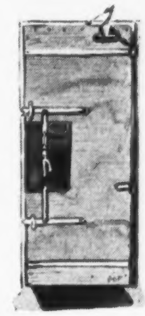
BELL LABORATORIES Chess Club is having an interesting year for members of the Laboratories who play the game. The Chess Club, under the chairmanship of H. L. BOWMAN, is in a leading position in the Commercial Chess League, which is composed of ten New York City business firms. The program for 1946 includes a Ladder Tournament that will run through to May and for which every Laboratories member is eligible and is invited to join. Regular bi-weekly meetings for informal or serious play are held every other Tuesday evening in the conference dining room at West Street.

F. E. STEHLIK visited The Mountain States Telephone and Telegraph Company in Denver to test initial installation of single-sideband program circuits used on type-K carrier circuits.

J. R. PIERCE, in the *Physical Review*, November 1 and 15, 1945, has written a Letter to the Editor on *Electron Beams in Strong Magnetic Fields.*

S. E. MILLER, on January 3, delivered a lecture entitled *Reception* at the Western Electric Company, Kearny. This was the fourth of a series in the Radar course sponsored by the A.I.E.E.

J. M. DUNHAM, J. W. EMLING and U. S. FORD were in Jonesboro, Ark., completing arrangements for a field trial of rural telephone service by power-line carrier, in coöperation with representatives of the Craighead Electric Coöperative, the Rural Electrification Administration and the Southwestern Bell Telephone Company. They were also in Selma, Ala., to complete installations for a similar trial of the same type of rural telephone system in coöperation with the Alabama Power and the Southern Bell Telephone and Telegraph Company.



LT. COL. J. W. MCRAE spoke on the subject *Paragraph Trooper* at the meeting of the Deal-Holmdel Colloquium.

G. T. KOHMAN, H. W. HERMANCE, C. F. HEFFT, W. E. VIOL, G. H. DOWNES, D. F. SEACORD, V. F. MILLER and B. F. RUNYON were in Pittsburgh from December 3 to 5 to discuss, with representatives from A T & T and various associated companies, the application of new methods and tools for maintaining base metal contacts.

P. W. BLYE presented a paper on *Rural Power Line Telephony* before the A.I.E.E. North Carolina State Section in Raleigh.

This advertisement is the first of a series of double-page spreads telling how the Laboratories and the Western Electric, working as a team, have contributed to fundamental progress in radio technology. The series is being prepared by the Newell Emmett Company, who are responsible for Western Electric advertising

The Bell Laboratories series of technical advertisements, one of which is shown on the opposite page, appears in the magazines listed in the table below

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